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ABSTRACT

The major purpose of the research reported was to assess whether developmental changes in performance on standard psychological tests may be more a reflection of educational experience than maturation or traditional socialization practices. The investigation was reported in three phases: 1) description of the general and specific experimental environments in which the experimental studies were conducted; 2) presentation of the results of an education-demographic survey conducted in 17 towns on the Yucatan peninsula; and 3) an account of a series of experimental studies designed to represent a variety of cognitive skills. The basic scheme of these studies was to work with children of varying ages and educational experiences, plus one or more groups of adults whose educational experience matched that of one of the groups of children. It was concluded that educational experience has a profound effect on cognitive development as displayed in the formal test situations currently in use in all industralized countries to measure such development. Appended are the results of a demographic survey, modernity prediction scale, scoring for the scale and survey, and results of a pilot study of instructional variation. (Author/KSM)

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The influence of educational experience on the development of cognitive skills as measured in formal tests and experiments: a case study from the Mexican states of Yucatan and Quintana Roo

Final Report: Grant No. OEG 1695

PREFACE

The research described in this report was initiated in January 1971 and supported by OE until 1973. At that time, owing to circumstances that were unforeseeable at the outset of the work, the original program of studies was incomplete. Completion of data collection and the writing of this report were made possible by a grant from the Carnegie Corporation of New York.

We would like to emphasize that the current report describes work still in progress. While data collection has been completed, the analysis of these data is by no means complete. In particular, we are now in the process of analysing the data from the demographic survey with the aim of producing a plausible causal model of the factors accounting for the grade at which a student drops out of school. The reports of several experiments are less thorough than we deem necessary in a finished product.

We offer no overall summary of the work at the end of this report because the nature of the summary will depend upon the results of analyses still in progress. However, we can with some confidence conclude that educational experience has a profound effect on cognitive development as displayed in the formal test situations currently in use in all industrialized countries of the world to "measure" such development. Since there has been some uncertainty about the efficacy of education in promoting school-relevant cognitive skills in recent social science writings, this conclusion may prove of considerable interest to scientists and policy makers alike.

The assistance of several people has been instrumental in permitting us to carry on this research. We are particularly indebted to Raoul Vela, Manuel Medina, and Francisco Ix Kan for their assistance in collecting data on the Yucatan peninsula. The hospitality of the people of many towns, particularly Bacalar and Ticul, was essential to our work.

Tony and Jo Sanders, Charles Lave, Jim Mueller and Lupita Sharp, have all helped in ways that were, and remain, invaluable to us. Critical comments and suggestions from Professors José de Jesus Morales Rosas of the Normal Regional de Bacalar and Duane Metzger of the University of California, Irvine, were also invaluable.

INTRODUCTION

This research was begun with two purposes in mind, only one of which survived as a major feature of this report. First, we sought to explore the potential of transforming learning experiments into teaching experiments. Building on the results of previous research in rural Liberia (Gay and Cole, 1967; Cole, Gay, Glick and Sharp, 1971) we sought to determine if repeated exposure to particular learning experiments (e.g.free recall, discrimination learning) would result in "learning-to-learn" the skills needed to perform well on those tasks.

Work along this line continued for only a brief period in 1971 owing to difficulties we had in maintaining an adequate fixed site in Liberia at that time. One publication resulted (Scribner, 1974) that demonstrated that if uneducated Liberian (Kpelle) tribal people could be induced to categorize a stimulus array in a stable manner, their subsequent recall for this array was organized in the way that they categorized. These results are consistent with our previously published results pointing to production of a structure as an activity not spontaneously engaged in by uneducated adults. No training study, however, was undertaken.

Of particular interest in view of our later work, was the fact that the nature of the categories used to partition objects varied systematically as a function of exposure to modern technological society, while the category-recall function remained more or less constant. These results led Scribner to conclude that experiences other than education (particularly the organization of one's work) can operate in a manner similar to formal education in modifying some aspects of cognitive behavior.

The major portion of the research to be reported was focused on its second purpose: to assess the generality of our Liberian studies suggesting that developmental changes in performance on standard psychological tests may be more a reflection of educational experience than maturation or traditional socialization practices.

Our previous Liberian research, as well as other research on this problem prior to 1971 (e.g. Greenfield, 1966), had been largely restricted to West Africa. Furthermore, the age range of the people studied tended to be truncated owing to the relatively recent availability of formal (Westernized) education in that part of the world.

For this and other reasons (including proximity and an extensive background of published linguistic and ethnographic data), we chose to conduct our research on the Yucatan peninsula in the Mexican States of Yucatan and Campeche, and the Federal Territory of Quintana Roo. The investigations which follow can be roughly divided into three phases: First, a short description of the general and specific experimental environments in which the experimental studies reported in Phase III were conducted. The specific description includes the some 37 towns and cities ranging in size from Merida (population roughly 300,000), the capital of the State of Yucatan to small, exclusively farming communities with populations of less than 500,

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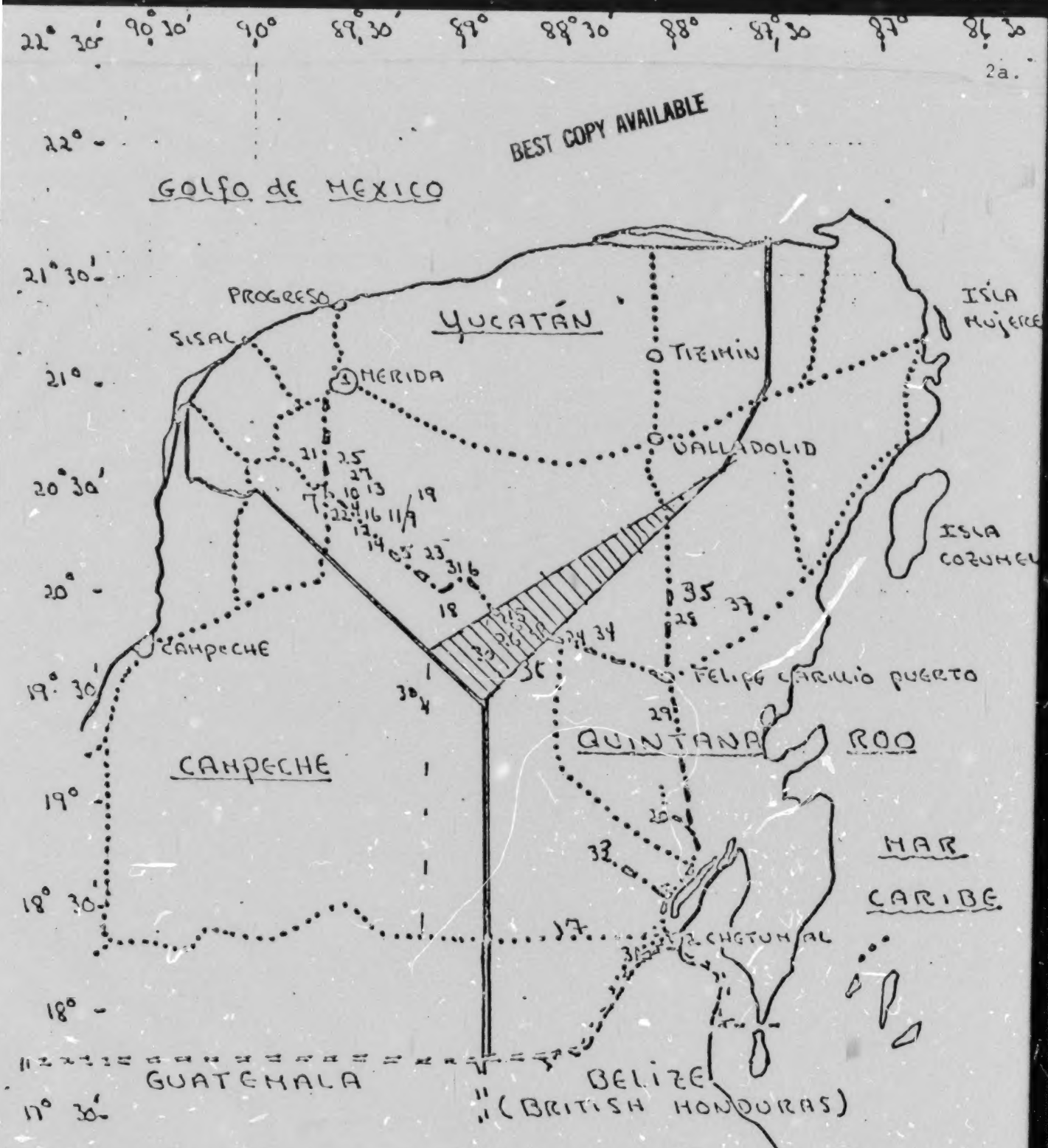

FIGURE 1. EXPERIMENTAL TOWNS - ORDER IS SAME AS TABLE 1. (CROSS HATCHED AREA IS DISPUTED by YUCATAN.)

such as 5-de-Mayo, that formed the sites for all of the experimental studies. In addition, the specific description includes a brief summary of both the structure and content of the Mexican educational system as it existed during the period in which the experimental studies were being conducted - from January 1971 to August 1974. Secondly, we will present the results of an educational demographic survey conducted in some 17 of the 37 experimental towns representing a range of sizes and economic activities that we felt were representative of the environment of the subjects drawn for our experimental studies. 448 adults ranging in age from 14 to 85 ($\bar{x}$=35.49) with a mean grade level of 3.25 participated in this aspect of the work, the aim of which was to determine the demographic variables associated with school attendance. A short form of Inkeles' modernity scale (Smith, D.H. and Inkeles, A. Sociometry, Vol 29, pp 353-377, 1966) and a subtest of the Wechsler Adult Intellegence Scale adapted to conditions in the Yucatan were incorporated in this survey. The third, and major part of the project consisted of a series of experimental studies designed to represent a variety of cognitive skills. The basic schema of all these studies (the details of which will be given in connection with each) was to work with children of varying ages and educational experiences, plus one or more groups of adults whose educational experience matched that of one of the groups of children. Thus, for example, a typical design would include first grade students (aged 6 years), sixth grade students (aged 12-13 years) and a group of adults (aged 18-30 years) whose formal educational experience was terminated between the first and third grades. The question of interest then became: Does performance of the adult group conform to what we would predict on the basis of their age or their educational experience? Although a few of the studies to be described here include comparisons between populations coming from towns differing in their proximity to traditional Mayan customs and economic activity, the general paradigm described above will be the rule for the experiments to be reported.

I. Experimental Setting

The Yucatan peninsula lies in the extreme southeast of Mexico and juts north separating the Gulf of Mexico from the Caribbean Sea. This region of Mexico prides itself on its ancient cultural heritage (where the concept of zero, developed trade routes, written language and great archeological complexes were but a few of the features present) and its historical independence of Mexico City. Many Mayan and Mestizo[1] residents of the area still refer to themselves as "Yucatecos" and Yucatec Mayan (thought by many to be the oldest of the seven presently spoken Mayan languages) is still the dominant language and is in many cases the only language, or the preferred language of a significant proportion of the rural inhabitants of the peninsula. Active resentment of the federal government, although apparently on the decline, is still not uncommon, although the fratricidal "Caste War" which began in 1847 was officially put down almost 100 years ago.

Although some light industry and a tourist trade exist in the capital cities and some of the larger towns, between 50 and 60% (depending how one counts) of the inhabitants earn their livlihood directly from agriculture where the major good crops are corn, beans, and citrus fruits and the major cash crops are henikin or sisal in Yucatan and chickle and precious woods (most notably mahogany) in the federal territory of Quintana Roo. Towns vary in size from the capital of Merida to tiny "ranchos" of only a few houses run by a single extended family.

Virtually all of our research was conducted in the 37 cities and towns extending from Merida in the northwest of the peninsula along Mexico Route 184 to Chetumal in the extreme southeast of the peninsula that are listed in Table 1 and are pointed out on the accompanying map. Table 1 represents a sort of incapsulated presentation of the critical features of these towns. The order in which the towns are listed is a composite rank order of the towns rated traditionality constructed from fifteen separate rank orderings collected from one of our research assistants who had worked extensively in each of the towns. The rank orderings were collected separately about once a month for a period of a year alternating rankings from least to most traditional with rankings of most to least traditional. The use of a single informant in collecting data of this type presents problems of which the authors are well aware, but which could not be avoided in this case since only one of our assistants was familiar with all of the towns used for our studies. These limitations aside, there is reason to believe that composite rank ordering presented is highly reliable. Test-retest Spearman correlations for all fifteen rank-orderings ranged from +.79 to +.98, with a mean of +.887. Furthermore, Spearman correlations with three other assistants for tradition rankings of towns known to both informants were universally above .80.

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1. A mestizo is by definition a person of mixed Indian-Spanish ancestry, but since this description fits nearly everyone, mestizo has come to be operationally defined in our work as bi-lingual with some education.

Experiment towns rank order by rated tradition least to most

| | Characteristics | | |

The features listed in Table 1 were collected in a somewhat different manner. Working with an informant different from the one that had done the rank orderings, a list of some 57 characteristics thought to reflect town sophistication was constructed. During the course of the work on the demographic survey (to be reported in detail later) each of the towns was visited and rated for the presence or absence of a given characteristic at the time when the experimental work was done in the town. Exceedingly general or specific items were eliminated from analysis and a resulting list of 28 characteristics retained. It is this list that appears in Table 1. Finally, the characteristics were re-arranged according to the similarity of their patterns of "+'s" and "-'s" to give the composite figure presented in Table 1, where the pattern appears relatively clear-cut.[1] Two major groupings appear - the large (population>5000) towns and cities with some light industry, central markets, and complete social servies in the upper left-hand corner, and the small, predominantly agricultural, Mayan communities in the lower-right. The towns in-between may be considered transitional between the two and are in many cases satellites of the first group of towns. These variations in sizes, ethnic composition, and occupation of the inhabitants coincide with a number of other variations among inhabitants of the peninsula which we explored in our educational-demographic survey to be described below.

As should be fairly clear from an inspection of Table 1, one of the key features that reflects the sophistication, or alternatively transitionality or lack of traditionality of a town, is the level of education available to its inhabitants (the correlation between grade of school in town and our scale of town traditionality was -.885 for our sample of towns). In fact, for our work with the demographic survey we used grade of school in hometown as a measure of town traditionality for all but questions dealing with attitudes, since this effectively eliminated biases due to age and migration, especially in the case of Bacalar where better than 90% of the adult inhabitants have migrated from elsewhere on the peninsula.[2] Naturally, aside from being an indicator of the sophistication of a town, they are also an environment in and of themselves for those that attend them. Physically, the schools may show a great deal of variability (where the typical rural school may be a three-room building with more than one grade taught in a room; the typical urban school closely approximates what we have in the United States) from location to location. But in terms of structure of the educational system and content of the curriculum everything is remarkably constant throughout the republic.

Although there are variations, the following may be considered typical of the republic and representative of the structure of the system in Yucatan and Quintana Roo. For our purposes the system may be broken down into four levels:

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2. This, of course, is the grade of school in hometown at the time when the interviewed subject would have been attending school.

1. See Stefflre, 1965 or Cole et al. 1971 for a more complete description of this technique.

1. primary school (grades 1-6)
2. secondary school (grades 7-9)
3. preparatory and technical (grades 10-12, 13)
4. professional or university studies

Primary school education is uniform throughout the republic in that no matter what the institution - federal, state, private or church schools - every student receives the same basic curriculum, which by American standards is very sophisticated, and may be divided into the traditional categories (1) reading (lingua nacional); (2) mathematics; (3) the study of nature; (4) geography; (5) civics and history.[1] Much of the first year is devoted to teaching reading skills as one would expect, but interlaced with the readings are materials relevant to the other major areas of study that will emerge as separate entities in the later grades. It is this pattern that is characteristic of the primary grades. Basic concepts such as fractions and areas in mathematics, public health in the study of nature, are introduced to the student in the very earliest grades and with each succeeding year the basic concepts are repeated and new concepts added to the basic framework so that by grade 6 the student has a basic framework that will allow him to continue his education or will serve him in good stead for day-to-day practical life in Mexico. Using this system, a student who has only passed through grade 3 has been exposed to the following concepts in Mathematics, for example:

1. larger, smaller, equal to
2. tens and hundreds, units, thousands
3. addition, subtraction, multiplication and division of 3-digit numbers with remainders
4. common fractions
5. decimal fractions
6. Mexican monetary system
7. metric system
8. measures of area and volume
9. geometric figures - the circle, square, rectangle, triangle - their perimeters and areas
10. solid figures - sphere, cube, cone, cylinders

By grade 6, all this information has been integrated into a general base where the student, through his mathematics, has progressed to simple algebraic formulations; in the study of nature he has a rudimentary knowledge of public health and ecology and a highly detailed knowledge of the structure of his own body and the complete biological classification system. In reading, he has progressed from four-line poems by Garcia Lorca in grade 1 to topical essays by both Spanish-speaking and foreign authors in grade 6. Similar examples could be given for the remaining areas of study. At the risk of appearing repetitive, the primary school curriculum can best be described as highly practical, especially in the areas of mathematics and science, where the emphasis is on introducing at the

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1. Note that as this report is being written, the educational system is undergoing a massive revision, both structurally and in presentation of content. This has no effect, however, in what follows since the description pertains to the system in effect at the time of our studies.

earliest possible opportunity concepts that will be of immediate practical use in the child's life, and adding to and clarifying these basics with each succeeding year.

Upon completion of primary school the student, if he is able to, passes on to secondary school (grades 7-9) where a more traditional curriculum is provided. Grade 7 is an intensive review of the primary curriculum and may be considered an extension of the first 6 years. In grades 8 and 9 the student must choose between two programs of study - a vocational (technologica) or a preparatory (preparatoria) course of study - the first giving the student a skill (carpenter, electrician, dress designer, for example) and the second providing the base for further study, a plan that is quite similar to that found in American high schools, but introduced at an earlier grade level. The programs are not mutually exclusive, and the system is flexible enough to allow for transfer from one program to the other. In the preparatory course the student, by the time he has finished grade 9, has had trigonometry, algebra, plane and solid geometry, world history, social sciences, and national language, and may have elected one or more languages and a selection of more specialized electives.

Upon the completion of Grade 9, the student may continue to one of three advanced schools; (1) preparatoria (a course of three years consisting of grades 10-12 to prepare for professional university studies); (2) technologica (a course of three to four years in specialized technical schools, producing technicians in a variety of areas including medicine, agriculture, geology, as well as in advanced work for the trades taught in secondary school; and (3) normal (a course of 3-4 years producing elementary school teachers). All three areas are open to secondary students who have elected the preparatory program, while only certain of the technologica programs are open to the graduates without further study on the secondary level. With completion of the preparatory program of three years, the student progresses directly to professional studies in the university in medicine (5 years), law, engineering, natural or social sciences. A liberal arts program as we know it in the United States is not available. In the past, Normal students could elect, after a year of social service, to continue teaching at the primary level or to continue to Normal Superior in order to qualify after four years of additional study for a teaching position in secondary school. At present, with the extension of the Normal program to five years, a Normal graduate can elect university professional studies and is exempt from the entrance examinations required of preparatory course graduates. Five of the towns and cities that were sites of our investigations had one or more of the programs mentioned in this paragraph: the capitol of Merida has all of the above including university studies on the professional level; Chetumal has technologica and preparatory; Ticul has a preparatory course, Tekax has an agricultural technologica, and Bacalar, a five-year rural normal for education of primary school teachers. In addition, each of these five, along with three others,

Peto, Muna, and Kilometro-50-Morales, had one or more secondary schools. For the remainder of our towns, education was limited to six full grades or less.

This then, is the system as it exists at present, and it is the product of intensive government action over the last 25-30 years that has made education available at some level for the majority of the residents outside of the largest towns. Here we will single out some of the variaties of educational experience of Yucatecan residents which have proved strategically useful for a study of education and cognitive performance. In addition to mere availability of education, the situation is further complicated by the fact that in many areas a language problem exists with the children coming to school speaking only Maya while their teachers speak only Spanish. As we will show in more detail later, while the younger generation of Yucatecans is considerably better educated than older generations, the distribution of educational experience both within as well as between generations is quite marked. This heterogeneity, as can be seen from the general description of our basic experimental design above, was a basic resource in our work. In addition to the mere fact of availability and language (more of which will be said later) economic factors would clearly appear to be paramount in determining how long a child attends school.[1] During the period in which this work was conducted, the minimum daily wage in the State of Yucatan was roughly 28.00 pesos ($2.24 American) and 41.00 pesos ($3.28 American) in the Federal Territory of Quintana Roo, giving the average worker in Yucatan a monthly income of roughly $58.00 a month. The equivalent figure for the Federal Territory of Quintana Roo is roughly $86.00.[2] These figures are to a degree misleading in that they assume that the person is employed and works a six-day work week, assumptions that are not justified for a large number of our subjects or subjects' parents in that many are self-employed as farmers, or although employed, work only a limited number of days a week or hours a day.[3] Those self-employed as farmers vary greatly as to what they earn, both as individuals and as groups. The most important variation being between the State of Yucatan and the Federal Territory of Quintana Roo where in a good year farmers in the former appear to earn less than the federal minimum on the average while in the latter they probably earn more.

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1. Strictly speaking availability, naturally, is economically determined.with those who continue on to secondary, for example, from a town with only a primary school having the parents who can afford travel expenses in addition to educational costs.

2. Intercambio, the business magazine, Mexico/Great Britain, January, 1974.

3. Exact salary figures can be found in appendix I.

The following represents an estimate of the cost per day and month for one child in each of the grades 1-9.[1]

Grade	Expense/Day Pesos	Total Cost/Month Pesos	Dollars
1st & 2nd	1.00 personal 2.00 supplies	60.00	= $4.80
3rd, 4th & 5th	2.00 personal 3.00 supplies	100.00	= $8.00
6th	2.00 personal 5.00 supplies 1.15 3 uniforms	162.50	= $13.00
7th	2.00 personal 5.00 supplies 1.15 3 uniforms	162.50	= $13.00
8th	8.00 personal 8.00 supplies 1.15 3 uniforms	342.50	= $27.36
9th	8.00 personal 10.00 supplies 1.15 3 uniforms	382.50	= $30.50

These figures represent a well-equipped student, so to speak. A student can always get along with two uniforms instead of 3, nothing to eat, no typewriter and other people's books, etc.

As can be easily seen, the cost of education increased dramatically after the second grade, with a major jump coming in the sixth grade and during secondary school. One of the major sources of increase in secondary school is the cost of books. Textbooks are provided gratis for all elementary school students by the government, but must be paid for in secondary school. Although there are a limited number of scholarships available in secondary schools, real government aid in the form of scholarships is not available until after the 9th grade. Thus, for workers of even relatively high income, secondary school becomes a real watershed, especially if the student comes from a large family (average family size of those interviewed in the educational survey reported below was seven, i.e. two adults and five children) where many children may be studying simultaneously. For those families of lower income, such as farmers and campesinos in the State of Yucatan, every year of successive education beyond grades 2 or 3 may be an overwhelming

1. Note: this is a rough estimate of costs collected during June, 1973.

burden. Finally, Mexico, as the United States, is suffering from the current world-wide inflation, especially in essentials.[1] All of these conditions combine to make school attendance quite variable among the Yucatecan population. Although virtually everyone between 7 and 25 years of age from larger towns has attended school at some time, many older people in all areas and many younger adults from rural areas have never done so. Moreover, as we will show in some detail, many people, either by virtue of economic necessity or the absence of educational facilities, have attended school for a very short time - sometimes fewer years than is necessary to become literate in Spanish.

II. The Educational Survey

Appendix 3 contains the questions asked on our educational-demographic survey plus the distributions of some of the major variables, and the scoring schemas used for the modernity questions and the WAIS task. In what follows we have summarized the information which we believe to be critical to an overview of educational opportunity in rural Yucatan and the factors which may induce or force children out of school prior to the completion of secondary school.[2] The final section presents a regression model that predicts years of education for the sample as a whole and for two important sub-groupings. A regression model predicting scores on the modernity questions is presented in Appendix 2, while a third model predicting performance on the WAIS similarities task will be presented in connection with the experimental results described below.

The Sample

A total of 446 adult subjects between the ages of 16 and 85 years were interviewed between July 1973 and August 1974. All of these subjects are represented in the summary tables that follow, while 440 of the total of 446 are represented in the final regression models. Table 2 presents some of the important descriptive aspects of the total sample of 446.

Insert Table 2 about here

Specific information on the towns and the number of subjects selected from each town can be had by referring back to Table 1. In each case, with the exceptions of Muna and Teabo, an effort was made to sample 5% or more of the adult population. (Thus, for example, the population of Ticul is 20,000 approximately, the average family size is 7, so there are approximately 2,800 families of which 154 or 5% were sampled). Actual sampling was a modified strata sample where the interviewer was asked to obtain interviews from four people

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1. The average increase in 10 basic foodstuffs in the period July-December, 1973 was 35% in one major town in the Federal Territory of Quintana Roo.

2. 16 yrs is the age that, under optimal conditions, one would complete secondary school.

Age	N	Proportion
14-20	87	.195
21-25	64	.143
26-30	59	.132
31-35	46	.103
36-40	48	.108
41-45	32	.077
46-50	28	.063
51-55	24	.054
56-60	16	.036
61+	42	.094

Grade	N	Proportion
0	105	.235
1	37	.083
2	78	.175
3	78	.175
4	44	.010
5	19	.043
6	20	.045
7-9	42	.094
10-12	13	.029
13+	10	.022

Sex	N	Proportion
Male	271	.608
Female	175	.392

Town Rating	N	Proportion
Very Modern	80	.179
Modern	168	.377
Transitional	98	.219
Traditional	87	.195
Very Traditional	13	.029

Education	N	Proportion
Non-Literate	105	.235
Adults with education	293	.657
Students	48	.108

Table 2

Characteristics of sample

in the age range of 16-30, two people in the range of 40-56, and two people in the range above 56 for every 10 persons sampled. He was also told to make sure that women were adequately, but not necessasarily equally represented. Our original intention was to sample only those that had had some degree of formal education since our major concern was those that had failed to continue formal education after they had started, and funds were limited at the outset of the project. With additional funds, however, it was possible to expand the sample so that within the constrictions of strata sampling across age, any person could be selected. Naturally, this sample represents only those that would cooperate with the interviewers, but non-cooperation was minimal since each person who cooperated was paid 20.00 pesos ($1.60) for his participation (a figure that for many of our subjects represented better than 50% of a day's wages). Non-cooperators were relatively more common among women than among men due to social considerations prevalent in Latin American culture. In addition, sampling in the larger towns was done so that equal numbers were represented from each barrio in addition to each group mentioned above. Finally, it should be stated that the objective of this survey was not to obtain a sample representative of the population of Yucatan as a whole, although we feel that this has been fairly well accomplished, but rather to obtain a sample that we felt was representative of the population from which our experimental subjects were drawn. Since the great majority of our subjects were drawn from the populations of Ticul and its satellites and Bacalar Quintana Roo, these towns are the towns most heavily represented in our survey.

Specific Factors Influencing School Attendance

1. Fathers' social position

Table 3 contains the distribution of years of education as a function of father's rated social position on a scale of seven. We have elected to use a scale of social position rather than one of estimated income for two reasons, the most important of which is the regional variation in salaries or wages referred to above.[1] A second, and equally important reason, is variation over ages where incomes have changed and continue to rapidly change today, but social position appears to remain more or less constant. It is clear

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Insert Table 3 about here

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from the table that it is extremely unlikely for someone whose father's occupation falls in categories 1 or 2 (earning about 35 pesos or less a day at present rates) to obtain a secondary education. It is only when one progresses to category 3 (semi-

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1. Estimated social position seems to largely reflect income as is witnessed by a positive correlation of +.775 between the two for the sample from which our scale was constructed.

Scale Value	Social Position	0	1	2	3	4	5	6	7-9	10-12	13+	Total N %
6 & 7	Commercial & Professional *	.00	.00	.08	.08	.13	.10	.20	.20	.10	.13	40-9%
4 & 5	Gov't & Skilled Employed	.00	.00	.04	.08	.21	.17	.15	.17	.10	.08	48-11%
3	Semi-Skilled Crafts	.07	.05	.07	.24	.12	.11	.08	.19	.05	.01	83-19%
2	Unskilled Employed	.08	.10	.31	.27	.08	.04	.06	.04	.02	.00	51-11%
1	Agricultural Self-Employed	.41	.11	.19	.15	.09	.02	.01	.03	.00	.00	223-50%

Table 3: Father's Occupation x Education
Included are 445 of 446 Interviewed Subjects

*The labels employed here reflect the majority membership of the category. Scale value 7 (professional e.g. Doctors, Lawyers, etc.) was not represented in our sample.

skilled workers, cash crop farmers, and certain small businessmen) such as educational level, becomes a distinct possibility. This same point is made quite strongly in our analysis of data of 158 adults between the ages of 16 and 30 years (the age range employed in many of our experimental studies for the adult groups) where there was a highly reliable correlation of .42 between father's education and subject's education.

2. Age and sex

Table 4 contains data on the number of years of education reported by respondents to our questionnaire for themselves, their siblings, and their children for all those that were twelve years of age or older at the time (i.e. for all those that, under optimal conditions,should have completed or be in the process of completing primary school). The data are compiled separately for people in four different age ranges and for men and women.

Several conclusions can be drawn from inspection of the Table. In general, younger people report more years of school attendance than older ones, and only in the youngest group do we observe a substantial proportion going beyond elementary or primary school. The peak at the relatively early grade of 3 is almost certainly reflective of the fact that in many smaller towns today and in many more towns in previous years, schooling terminated at the third grade (presumably the level necessary for basic literacy). A second peak at six years can be attributed to a similar cause. (Also not to be forgotten as a possible or probably causal effect is that these grades represent the first steps in increased school costs). Note also that in the age range from 36 up, the most frequently reported amount of schooling was none.

Insert Table 4 about here

A marked tendency for males to obtain more schooling than females, especially at the younger age ranges, is also clear from the Table. This tendency is apparent even in the youngest age group where proportionately more males have education in excess of grade 5. It is much stronger in the generation over 25 where it is relatively rare for a woman to complete sixth grade, and rare indeed for her to complete secondary school.

3. Language

Data relating number of years of education to the language spoken by the respondents are shown in Table 5. The data are summarized in three panels. Panel 1 contains data relating years of education to the first language spoken by the respondent. Panel 2 contains analogous information for the language or languages spoken in the home of the informant and panel 3, the data for languages that the respondent says he or she can speak, regardless of the frequency with which it is spoken.

		Education in Years										
SEX	AGE	0	1	2	3	4	5	6	7-9	10-12	13+	Total
Male	12-25	.10	.04	.13	.15	.11	.08	.14	.16	.06	.03	713
Female	12-25	.15	.07	.18	.17	.10	.10	.09	.09	.02	.02	657
Male	26-35	.21	.09	.12	.24	.13	.06	.10	.02	.02	.03	335
Female	26-35	.30	.10	.15	.18	.11	.04	.08	.02	.01	.01	303
Male	36-50	.32	.11	.16	.18	.09	.06	.05	.02	.01	.01	351
Female	36-50	.42	.08	.17	.14	.07	.04	.05	.00	.01	.01	269
Male	51 ≤ a	.51	.08	.11	.13	.07	.03	.05	.01	.01	.00	191
Female	51 ≤ a	.64	.07	.07	.10	.04	.00	.04	.04	.00	.00	112
Totals	age ≥ 12	.25	.08	.15	.17	.10	.07	.09	.07	.02	.02	2931

Table 4

Sex x Age x Education for 446 Interviewed Subjects, Brothers and Sisters of Subject, and Children of Subject for Age ≥ 12, Total N = 2931

All three panels in the Table speak to the disadvantage in educational experience that accompanies the use of Maya. While a majority of our respondents report that they are bilingual in Maya and Spanish, those whose first language was Maya, or who speak Maya at home, are significantly less educated than their counterparts for whom Spanish is the dominant language.

Insert Table 5 about here

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4. Town

In the introduction, we indicated that the towns in which our work was carried out varied from rather traditional, small agricultural centers where Mayan language and culture are dominant, through somewhat larger transitional towns, to modern towns where all social services are provided, various trades are common, and the population is predominately "mestizo."

As has been mentioned above, the size and sophistication of a town are related, among other things, to the amount of education that its populace is likely to receive. (In fact, the single best predictor of the sophistication of a town is the grade of the school in the town). There are many reasons for this, the most clearcut of which is that the smallest towns or settlements may have only three grades of school available for its residents, while the norm for transitional towns is education through grade six only. It is also the case that smaller towns are more likely to be inhabited by milperos, campesinos, and others at the bottom of the wage scale, and Maya is more likely to be the dominant language. The relationship between town and education for two distinct age groups ($12 \leq$ age ≤ 25 and $26 \leq$ age ≤ 50) for respondents is shown in Table 6. For purposes of this analysis, the towns have been grouped in five categories (that may be called;(1) very modern;(2) modern;(3) transitional;(4) traditional; and(5) very traditional) according to their composite rank order of tradition. These categories are "clumps" that appeared in order of increasing traditionality when the rank order data collected from one of our assistants mentioned above was scaled. The expected relationship between rated sophistication of the experimental town and years of education is readily discernable by inspection of the Table.

Insert Table 6 here

This cursory analysis of several major demographic variables related to duration of school attendance clearly demonstrates the non-uniform nature of the school experience of much of rural Yucatan's population. In the experiments to be described in later sections,

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Education in Years

			0	1	2	3	4	5	6	7-9	10-12	13+	Total
First Language	1.	Maya	.32	.10	.20	.15	.10	.04	.02	.04	.02	.00	331
	2.	Spanish	.03	.03	.10	.20	.11	.03	.10	.23	.06	.10	115
Home Language	1.	Maya	.47	.12	.16	.12	.03	.04	.02	.03	.02	.00	193
	2.	Maya & Spanish	.02	.05	.20	.28	.17	.09	.04	.11	.01	.02	98
	3.	Spanish	.08	.05	.16	.19	.13	.03	.10	.15	.05	.06	154
		2 & 3 combined	.05	.05	.17	.23	.15	.05	.08	.13	.04	.04	253
Languages Spoken	1.	Maya	.66	.16	.12	.03	.03	.00	.00	.00	.00	.00	115
	2.	Maya & Spanish	.10	.06	.21	.24	.13	.06	.06	.10	.03	.01	284
	3.	Spanish	.00	.06	.09	.13	.09	.02	.06	.28	.09	.19	47

Table 5

	Towns	Age	Years of Education 0	1	2	3	4	5	6	7-9	10-12	13+	Total
1	*Bacalar, Q.Roo	≤ 25	.08	.03	.07	.11	.09	.06	.14	.24	.09	.10	231
		26-50	.24	.05	.07	.14	.15	.06	.14	.05	.03	.07	249
2	Ticul,Yuc. & Muna, Yuc.	≤ 25	.07	.03	.13	.14	.11	.11	.18	.16	.06	.02	513
		26-50	.23	.07	.21	.22	.11	.06	.08	.02	.01	.00	469
3	Teabo, Yuc. Sacalun, Yuc. Mani, Yuc. Pustunich, Yuc. Yotholin, Yuc. Dzan, Yuc. Chapab, Yuc.	≤ 25	.05	.07	.14	.17	.20	.17	.10	.09	.01	.00	259
		26-50	.28	.13	.16	.22	.12	.04	.04	.01	.00	.00	240
4	Cocoa, Yuc. Mayapan, Yuc. San Jose, Yuc. Yunku, Yuc. San Antonio, Yuc.	≤ 25	.19	.11	.28	.23	.05	.05	.03	.04	.01	.00	303
		26-50	.47	.15	.15	.13	.05	.02	.03	.00	.00	.00	255
5	Tuzik, Q.Roo	≤ 25	.36	.06	.22	.24	.05	.03	.02	.02	.00	.00	57
	Cinco-de-Mayo,Q.Roo	26-50	.72	.07	.08	.10	.03	.00	.00	.00	.00	.00	48
	Totals	12-50	.21	.07	.15	.17	.11	.07	.09	.07	.03	.02	2624

Table 6

Town x age x education for 446 interviewed subjects, siblings of subjects, and children of subjects where $12 \leq$ age ≤ 50 years. Total $N=2624$.

*Note that for Bacalar, better than 80% of the population are immigrants from other parts of the peninsula and in some cases other parts of the nation.

we will use the relative absence of education among rural adults as a means of evaluating the role that education has in performance on cognitive tasks.

However, the fact that groups are naturally selected, and not created experimentally will pose a problem of inference. In a good many cases we will discover that cognitive performance changes more as a function of educational experience than age. We would like to attribute this fact to something about the school experience itself, but there is always the possibility that we are observing a selective mechanism at work whereby those who "naturally" develop the appropriate skills are those who remain in school.

While the data in Tables 3-6 clearly indicate that economic and cultural factors are associated in a major way with school attendance, this fact does not rule out the possibility, however remote it may appear to be, that selective factors operate at one step removed - that is, to put it bluntly, that only the relatively rich are smart enough to go to school beyond a few grades.[1] Such a line of reasoning would, of course, have to include being female, living in isolated villages, and speaking Maya as factors related to cognitive potential.

It seems far more likely to us that the data from our survey reflect the operation of socio-economic factors on people who would otherwise benefit equally, as groups, from the education experience.[1] In order to throw as much light on this issue as possible, the data from our demographic-educational survey have been analyzed in much greater detail than provided in Tables 3-6 to produce as complete a picture as possible of the factors related to years of educational experience.

Our approach has been to use the technique of step-wise multiple regression to identify the major correlates of educational attainment and to evaluate the <u>independent</u> contribution of each. Furthermore, we can, by this technique so control the order in which the variables are entered into the equation predicting years of school that we can exclude variables likely to be consequences rather than causes of educational attainment.

Fully cognizant of the weakness of this approach, we nonetheless think it useful as a means of providing as accurate an analysis as possible of the causes of the vast spread in educational experience which our data have revealed.

<u>A Preliminary Regression Analysis of Educational Attainment</u>

Listed in Table 7 is the final group of labels we decided upon for our present model.

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1. Those who favor genetic arguments would have to explain how a culture of such independent achievements could have degenerated so completely even with introduction of European stock.

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Insert Table 7 here

- -

The first step in attempting to predict the grade in school completed (GRADE) was to classify variables into categories, each of which might be operating either independently or in combination and all of which might be considered to be logically antecedent to the actual grade completed. In particular, one group of variables were grouped under the heading of parental influences, including father's education (PASED), father's occupation (PASOC), mother's education (MASED), and language spoken in the home (HLANG). The scale used for PASOC is highly correlated with income (r=.78), but a more direct measure, which might be more relevant to GRADE than income per se, is amount of income per child (operationally defined here as PASOC/SIBS+1). The respondent's sex, the degree of modernity of the town in which the respondent lived (TOWN) and the maximum grade provided by the local school (SCHOOL) were also included as potential determiners of GRADE. Finally, the degree of regular attendance (REGAT) was included as a separate variable, which may be differentially affected by the above mentioned variables, and also may be a direct determiner of grade completed.

- -

Insert Table 8 here

- -

The first problem was to specify the effects of parental influences, if any, on the variables of SCHOOL and REGAT since these are considered antecedents of GRADE but not conversely. The regression analysis, using SCHOOL as a dependent variable, revealed that both PASED and PASOC were significant determiners of SCHOOL whereas MASED was not. In addition to having a significant direct effect on SCHOOL, PASED also affects SCHOOL indirectly through PASOC. This conclusion follows because of the non-additivity of the variance accounted for by PASED alone (12%) and PASOC alone (12%) when both are included in the prediction (r^2=.16). The arrow in Table 8 is drawn from PASED to PASOC rather than vice versa since education generally precedes the selection of occupation. The degree of modernity of the town of residence (TOWN) is significantly related to the amount of schooling available in the town (SCHOOL). However, it is not clear whether either SCHOOL or TOWN should be considered logically or temporally prior, hence the relation between TOWN and SCHOOL has been indicated by a dashed line in Table 8. TOWN is also significantly related to HLANG, although not to MASED, PASED or PASOC, but the directionality of this effect is not obvious.

One reasonable interpretation of the analyses presented so far is that PASOC and PASED determine to a large extent the amount of schooling available in the town of residence. In addition, PASED and PASOC in combination with MASED are highly predictive of language spoken in the home, which in turn may be related to variables which can be summarized by a modernity index (i.e.TOWN), and this variable is also highly correlated with level of schooling available.

1) Town

2) Sex: 1=Male 2=Female

3) Age in Years

4) Civil Status: 1=Married 0=Single

5) Grade: Present grade or last attended in years

6) Siblings: Present # of Brothers and Sisters

7) Mother's Education

8) Father's Education

9) First Language: 0=Maya 2=Spanish

10) Home Language: 0=Maya 1=Both 2=Spanish

11) School: Grade of school in home town when the subject would have been attending

12) Father's Occupation: Fathers social position rated on a scale of seven from (1) Self Employed, agricultural to (7) Professional

13) Subject's Occupation: Subjects position rated on same scale as in 12

14) Number of Other Occupations

15) Travel: Number of towns subject reports he has traveled to or lived in maximum 9

16) Regular Attendance: Subjects reported attendance in school 0=Did not Attend; 1=Missed Often; 2=Missed Occasionally; 3=Never Missed. We treat this more as an attitude variable than an accurate report.

17) WAIS: Similarities score WAIS Scoring Method

18) Modern: Sharp Score of 7 Inkles Questions

19) R-Drop: Reason for Leaving School, 1=Economic; 0=Other

20) Impt: Attitude Question on Importance of Attending School, 1=Personal Improvement to 3=In National Interest or Interest of Others

Table 7: Variables Used in Regression Analysis of Demographic Data

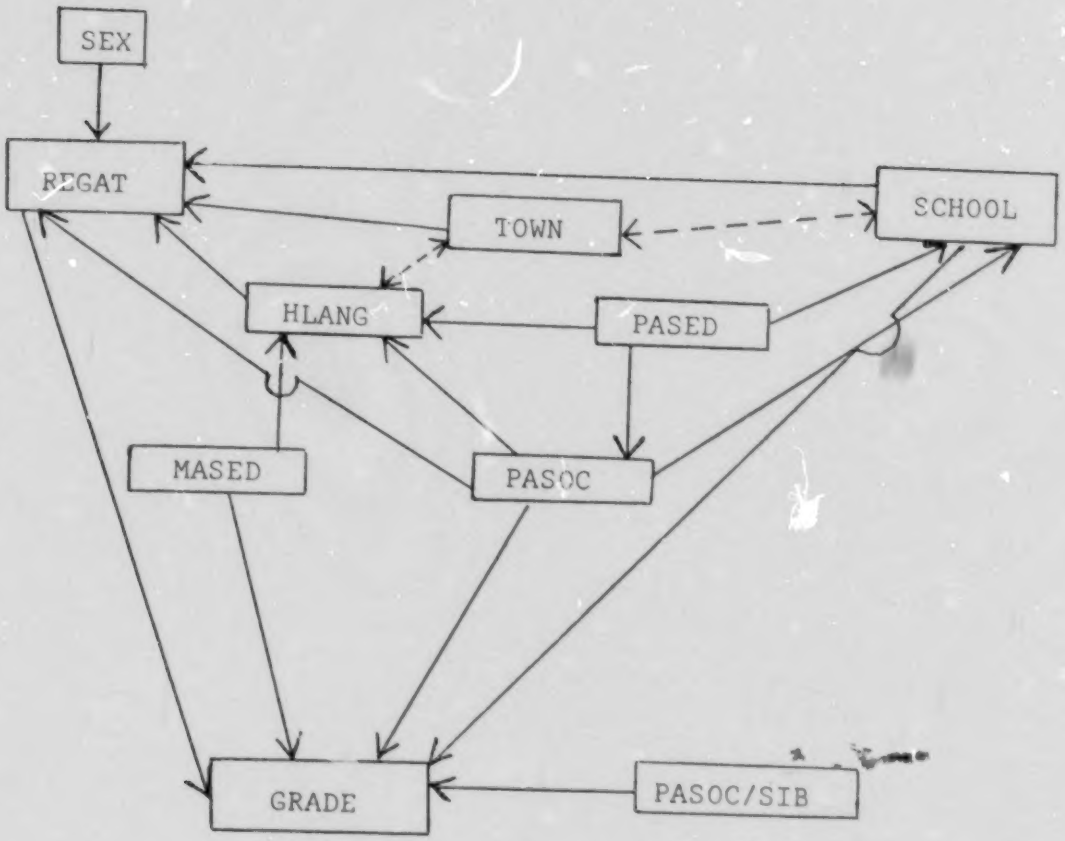

Table 8: Final model of the relationship among variables considered and their combined effects on grade achieved in school. Of the forty-five unidirectional relationships possible among the ten variables, the model includes only 18, indicating a very parsimonious representation; $R^2 = .59$.

Similar analyseswere applied to REGAT as a dependent variable, the results of which are also included in Table 8. As the Table indicates, SCHOOL, PASOC, HLANG, and SEX affect REGAT directly and PASED, MASED, and AASOC have an indirect effect. The direct effect of SCHOOL is presumably due to the facilitation of regular attendance through accessibility. SEX accounted for less than 1% of the variance reflecting a greater pressure to attend school for male children as compared to females, and perhaps the pressures for female children to help at home to a greater degree.

The effect of PASOC most likely reflects the operation of several distinct factors. The direct effect of father's occupation may be due to such factors as the need for the children of farmers to help at home. Also, the effect of expectations and the value of education from PASED is operating through PASOC. Finally, since PASOC is correlated with income, and regular attendence requires a substantial economic committment, REGAT would be directly effected.

The effect of HLANG on REGAT reflects both cultural factors as well as the probability of success in school. That is, families which speak Spanish at home would be expected to place a higher value on school attendance since modern Mexican culture predominates in the schools. On the other hand, if Spanish is spoken at home, any given child has a much higher probability of success in school, since Spanish is the language spoken by the teachers. Both of these factors would be expected to increase regular attendance. The importance of language is indicated by the fact that there is no independent effect of parents' education on REGAT once the effect of home language is included.

In the third stage of analysis, all of the variables considered above were entered into the prediction of grade achieved in school. As indicated by Table 8, REGAT, MASED, AASOC, SCHOOL and PASOC/SIB all contribute directly to GRADE. The effect of REGAT would appear to be operating through the increased chances for success which result from regular attendance. The model illustrates the effects of home life, expectations, etc. on GRADE as well as REGAT through MASED, and PASOC.

The effect of PASOC may be attributed partially to the needs of farmers for assistance by school-age children, but again it is clear that economic contingencies as well as the value of education in the home, and the availability of academic materials and assistance in the home are also important factors. Economic conditions are also partially captured in the significant effect of PASOC/SIB, but this variable accounted for only 5% of the variance.

The effect of SCHOOL underscores the importance of the difficulties, both economic and practical, which are involved in traveling to school outside one's town of residence.[1]

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1. This analysis is a first attempt at producing a reasonable and testable model. Further statistical work is currently under way by David Burns who has carried the analysis thus far

Attitudes Toward Education

Despite the fact that the above analysis argues quite favorably for the primacy of economic and cultural factors in the determination of who goes to school and for how long, it can always be argued that the real difference is in attitude, or motivation, or awareness on the part of the people. For this reason a major part of our questionaire dealt with questions that may more properly be termed attitudinal than demographic, and it is toward an examination of several of the more important of these questions that we now turn our attention. Questions included were selected to show not only attitudes on the part of our sample, but also awareness or lack of awareness of some of the conditions demonstrated by the analysis of the demographic data.

As might be expected, subject's self-reports on why they left school or never attended school closely followed what we would have predicted on the basis of the results of the demographic analysis and the regression model. With students eliminated from the analysis the distribution of reasons and their frequencies were as follows.

I. Direct Economic

"there was no money"
"I had to work" 49%
"I had to help in the house"
"for lack of economic resources

II. No school Available

"there was no school in that epoch"
"the school went only to grade 3" 16%
"there were no teachers"

III. Did Not Like It 15%

IV. Parental Intervention

"my parents didn't take me" 7%
"my parents didn't like it"
"my parents took me out"

V. Too Old, or Sickness 5%

VI. Preferred Work 4%

VII. Other

Married, finished studies, no reason 4%

Clearly, self-reports of our subjects who left school before finishing their studies, or who never attended school reflect what we would expect on the basis of our model with 65% of the responses directly represented in the model (economic and school in town) and another 12% (parental intervention and age and sickness) probably attributable to primarily economic factors.

Question #32 attempted to get more at the attitudes the people in the survey had toward education. Rather than self-reports the subject was asked "What do you think of those that don't continue their education after they have finished primary school?" Here the students were included in the sample, and if the subject gave more than one response all of his responses were recorded. The distribution of responses was as follows.

I.	Economic	48%
	"perhaps they don't have the money" "they might have to work to sustain family" "no money for books"	
II.	Lazy, Have No Will, Don't Like It	24%
III.	Shame, Should Continue	9%
IV.	Prefer Work	4%
V.	Parental Intervention	3%
VI.	No School Present	3%
VII.	No Ability to Continue	1%
IX.	Other (Marriage, friends, no answer)	7%

Again, the largest single category of response on the part of our subjects was economic; they attributed to those who had completed primary school the desire to continue but the inability to do so for reasons that were primarily economic in nature. Of the remaining 52% of the responses, a convincing argument can be made that 39% (categories II, III, V, VI) represent a positive attitude on the part of those interviewed toward continued education[1]. The questions and responses reported above are more of the open-ended variety. When a close-ended or multiple-choice question such as question # 30 is presented, the primacy of economic considerations in the opinions of our sample is even more dramatic as the accompanying table of proportions indicates, where as full 75% of our sample listed the clearly

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Insert Question 30 here

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1. Note, that when asked directly if it was important to go to school to do well in Mexico today more than 90% of those interviewed replied in the affirmative.

economic alternative (money for these expenses) as the most important problem preventing students from continuing their studies.

Q.30 What is the Most Important Reason for Which Students Don't Continue Studying?

(A) Problems with their Families	4%
(B) No School Available	8%
(C) Responsibilities that Make it Impossible to Continue	3%
(D) Money for their Expenses	75%
(E) The Opinion of their Families or Friends	10%

Several questions reflected directly on attitudes toward education, and these universally demonstrated highly positive attitudes. For example, better than 90% of the sample argued that it is important to go to school to do well in Mexico today. Furthermore, 61% of the adults interviewed stated that they would like to study or continue their studies in a variety of areas if it were possible, regardless of their present age. With these considerations in mind we can ask (in view of the fact that the average education attained by our sample of 440 subjects was 3.25 years) what amount of education they think is necessary for a person to have today in Mexico. The following table presents the distribution of responses to Q. 13. What minimum amount of school do you think is necessary for a man to have to live well in Mexico?

I. Some Primary School	9%
II. Primary through Grade 6	24%
III. Secondary School	21%
IV. Preparatoria, Technologica, Normal	12%
V. Professional Studies	29%
VI. Advanced Studies	6%

The mean for this distribution was 3.45 on the scale of 6 indicating that on the average our sample thought that about 11 years of study was what a man needed to do well in Mexico. It should be noted, however, that the distribution is bi-modal and that a full 35% of the total sample felt that a minimum of professional studies was necessary.

In closing this section on attitudes, it will perhaps be of interest to see how attitudes in two areas not directly related to education mesh with the apparent results of the demographic analysis presented above. It will be recalled that sex (as determined by demographic analysis) and economic factors (as determined both by demographic analysis and self-reports of subjects) had highly significant effects on educational attainment, with males having the advantage over females and those coming from families of higher social position (as measured by father's

occupation) having the advantage over those lower on the scale. Two questions (#7 and #31) probed these areas directly with the following results. Question 17 asked our sample "Do you think that a woman has the same opportunity to study that a man has in Mexico?", to which a full 65% of our sample male, female and students replied in the affirmative, those generally replying in the negative being women and the more highly educated. More importantly, in view of the economic realities reported above was the response to Question 31,"Some say only the rich can study, what do you think?", to which a full 70% of our sample replied in the negative i.e.that the proposition was not true with those generally replying in the positive coming from the smallest and poorest towns. The results of these questions in apparent contradiction with the realities in Yucatan probably reflect a genuine lack of awareness in the case of the first question (#17), and an attitude that with determination, sacrifice, and perhaps a little luck anyone can succeed in the case of the second. (#31)

This, then, completes our analysis of the setting in which our psychological studies were carried out. The picture that emerges is that of a primarily agricultural setting with a proud ancient, colonial, and national tradition that is in the process of undergoing rapid changes and modernization with a population that, though limited in their aspirations in the past by factors of a chiefly economic nature, are fully cognizant of their present needs. From here we turn to the more specific questions of variety of educational attainment and cognitive process.

III. Experimental Studies

A. Free Association

As preparation for studies to be described in later sections of this monograph, and because the results are of interest in their own right, we carried out a series of studies of people's free associations to a set of common nouns which are clearly understandable in both Spanish and Mayan. A number of studies, including the work of Entwistle (1966) and Sharp and Cole (1972) have demonstrated population differences in free associate responding that seem to be correlated with educational achievement.

For example, in the work of Sharp and Cole it was found that the nature of associative responding differed quite sharply between young Liberians who had, or who had not attended secondary school. Those with the greater degrees of education were more likely to respond with words that were members of the same grammatical class as the stimulus word. Furthermore, when responding to noun stimuli, the responses of secondary school students were more likely to be of the same semantic class as the stimulus word.

Both of these results are of the sort that have been associated theoretically with greater cognitive development when the work was carried out within the United States (Entwistle, 1966) or Western Europe (Rosenzweig, 1961). Hence, it would be of significant interest to know if, as in the Liberian work, the more "developed" pattern of associative responding is associated with years of formal education, or more broadly with age.

Experiment 1

Stimuli: A set of 12 common nouns representing four instances each of the semantic classes clothing (huipil- a traditional Mayan woman's dress, sandles, shirt, and trousers), food (onion, tortilla, coconut, and bread), and animals (bull, horse, duck, and dog) were selected from a large list that had been constructed with the help of a series of bi-lingual informants. Special care was taken to make sure that the stimulus words were easily understandable in both languages and were of high frequency of occurrence.

Subjects: The subjects (20 per group) were drawn from the following populations.

1. 8 - 10 year old Mestizo children ($\bar{X}$ age=8.5, $\bar{X}$ grade=2.4)
2. 8 - 10 year old Mayan children ($\bar{X}$ age=9.7, $\bar{X}$ grade=2.0)
3. 16 - 40 year old Mestizo adults ($\bar{X}$ age-20.8, $\bar{X}$ grade=3.2)
4. 16 - 40 year old Mayan adults ($\bar{X}$ age=23.6, $\bar{X}$ grade=1.2)
5. High school students ($\bar{X}$ age=16.9, $\bar{X}$ grade=8.2)

The purposes of the study were two-fold, the most important of which, as mentioned above, was to investigate the nature of associative responding to nouns over varying ages, educational levels, and languages. A second purpose was to investigate the possible influences of instructional set on the nature of free association responses. This second concern grew out of a series of studies in free association, the primary purpose of which was to define the semantic structure of the domain of people-types and occupations. One highly unexpected result of that work, in view of our previous work in Africa, was that our subjects gave an inordinate number of adjective responses to the noun stimuli employed when our previous experience has been to expect almost exclusively noun responses. This result, along with an informal chat with the assistant who had administered the task, led us to believe that he had inadvertently changed the response set of the subjects by introducing adjectives as examples of responses into the instructions. Furthermore, a check of the literature at the time indicated that virtually all the formal studies gave nouns as the practice examples (and when responses were given as examples to the stimuli these were nouns). With these considerations in mind we conducted a small pilot study with 20 Mayan adults as

subjects[1], ten of whom received instructions with noun stimuli and nouns as possible responses to those stimuli, and 10 of which received the identical set of instructions with the identical nouns as examples of stimuli, but with adjectives as examples of responses. The result was a predictable and highly significant interaction between instructional set and form class of response ($F = 97.94$ d.f.$=2,36$; $p < .01$) i.e. those who received noun instructions gave nouns as responses; those who received adjective instructions gave adjectives as responses. The present study, in addition, to investigating the structure of responses to nouns with conventional noun-type instructions sought to extend the results of the pilot study to populations other than strictly Maya. Additionally, instead of instructions which gave only adjectives as examples of responses, the second set of instructions gave a group of examples that were mixed by form class. The above yielded a free factorial design with two ages (8-10; 16-40), two population groups (Maya and Mestizo) and two instructional sets (noun examples and mixed examples). In addition there were two groups of high or secondary school students one of which received instructions with noun examples, the other with mixed examples. Thus each sub-group contained 10 subjects (among secondary-level subjects only).

Procedure: Subjects were chosen haphazardly from the populations of 7 of our experimental towns (Ticul, Tekax, Xyatil, Kancabchen, Dziuche, Senor, and Sacalum) and two other towns (Carrillo Puerto and Limones) that were not on the original list, in such a manner that at any time during the course of the experiment, experimental groups contained roughly an equal number of subjects. The mestizo groups and the high school group received the following instructions in Spanish and were asked to respond in Spanish while the Maya groups received their instructions and were asked to respond in Maya:

> "I have here a list of words that I will read to you one by one. Each time that I (might) read you a word, I want you to tell me five words that you might think of. For example, if I hear the word house I think of building (red), post office (vivir) tienda (tienda), shoe shop (large), tortilla shop (work and building), or if I hear the word boy I think of girl (small), woman (man) and man (tall). Did you understand what I want?"

Subjects who received the instructions with nouns as examples received the instructions straight; those in the mixed condition received the words in parentheses as examples. If the subject displayed difficulty in understanding, the instructions were repeated. After a repetition of the instructions, no subject reported difficulty in understanding what was required of them. Subject responses were recorded in the order they were

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[1] See Appendix 4 for details.

given, and scored according to the proportion of responses that were of each of the form classes nouns, verbs, and adjectives. The resulting proportions were transformed using the arc-sin transformation, and the resulting scores subjected to analysis of variance.

Results: Ignoring for the moment the high school or secondary school subjects, the major result of the strictly factorial part of the experiment is presented in Figure 2, where the highly significant ($F = 16.82$, d.f. = 2,128, $p < .01$) instructions by

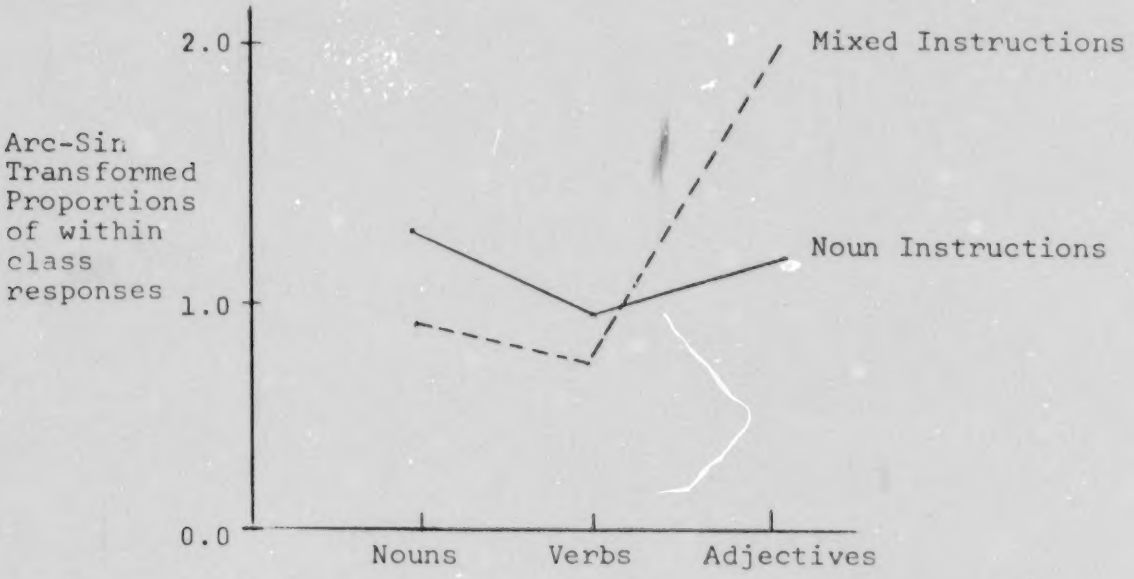

Figure 2.

form class interaction is presented indicating that the instructional set of the subjects significantly affects their responses to the word association task as was the case in the pilot study with purely Mayan subjects. The only other significant effect was the main effect for form class of response ($F = 24.433$, d.f. = 2,128, $p < .01$). Contrasts when using the Newman-Keuls procedure with $\alpha = .01$ indicated that this difference was due to the higher frequency of adjective responses which were of significantly higher frequency than noun and verb responses which in turn did not differ significantly from each other. One marginally significant effect, the Maya-Mestizo by instructions ($F = 2.851$; d.f. = 1,64; $.05 < p < .10$) interaction indicating that the Mestizo appear to be more affected by the mixed instructions, is of importance for what follows. It can be argued that this might be in part due to their higher level of educational attainment, in which case we would expect a really dramatic effect when the group of high school students was added into the analysis. Presented in Table 12 are the arc-sin transformed proportions for the secondary school students and the Mestizo adults (i.e., the two Spanish

speaking adult groups). The strong visual impression is confirmed

		Form Class of Response		
		Nouns	Verbs	Adjectives
Mestizo Adults	Mixed	0.87	0.84	1.83
	Nouns	1.56	1.10	1.01
Second. Students	Mixed	0.42	0.06	2.67
	Nouns	2.39	0.01	0.70

Table 12: $\bar{X}$ Transformed Proportion of Responses

by analysis of variance. Contrasts performed on the main effect for form class ($F = 39.90$; d.f. = 2,72; $p < .01$) with $\alpha = .01$ indicated that significantly more responses were adjectives than nouns which were in turn significantly more frequent than verbs. In addition, all of the higher order interactions with form class were also highly significant: Instructions x form class of response ($F = 65.90$; d.f. = 2,72; $p < .01$) groups x form class of response ($F = 14.328$; d.f. = 2.72; $p < .01$) and the triple order interaction ($F = 13.22$; d.f. = 2.72; $p < .01$). The interpretation of this in its simplest form is that both groups are affected by the instructional set (instructions x form class interaction) as was the case above, but that the secondary school students are differentially more effected than the Mestizo adults.

Structure of Associative Responding

In what follows attention will be paid only to the portion of the experiment where noun instructions were used, although parallel results in terms of communality of response, number of different responses, tightness of structure, etc. can be demonstrated for the different response sets when the mixed instructions were used. Presented in Table 13 are the results of a detailed analysis of the response sets of our 50 subjects from the five experimental groups when the noun instructions were used. It can be readily seen that the secondary school students apparently differ from the other groups in that they give fewer responses (those of higher communality)and that these responses are overwhelmingly of the same semantic as well as form class as the stimulus word. These impressions were confirmed by two separate analyses of variance, one on communality of response (total frequency of the four most common responses/divided by the total number of responses for each stimulus word) and one on number of responses of the same semantic class as the stimulus word for each stimulus word. The overall effect for communality of response (the ANOVA was performed on arc-sin transformed proportions)

	Maya Adults $\bar{X}$ Age 23.6 $\bar{X}$ Grade 1.10	Maya 8-10 $\bar{X}$ Age 9.7 $\bar{X}$ Grade 2.0	Mestizo 8-10 $\bar{X}$ Age 9.5 $\bar{X}$ Grade 2.4	Mestizo Adults $\bar{X}$ Age 20.8 $\bar{X}$ Grade 3.2	Secondary School $\bar{X}$ Age 16.9 $\bar{X}$ Grade 8.2
Total Responses	592	596	599	598	602
$\bar{X}$ Number of Different Responses	35.92	35.00	33.83	35.66	28.08
$\bar{X}$ Communality * Score #1	.23	.27	.29	.29	.32
$\bar{X}$ Communality ** Score #2	.29	.34	.36	.36	.43
$\bar{X}$ Responses of Same Semantic Class as Stimulus Word	9.67	8.00	6.41	9.83	35.42

* Score #1 (Range = .08-.80) Σ 4 common R/ΣR
** Score #2 (Range = .10-1.00) Σ 4 common R/40 (maximum communality)

Table 13: Analysis of Response Sets for Subject Responses to Noun Stimuli with Noun Instructions. Groups linked by solid line do not differ reliably from each other (α = .01)

was highly significant ($F=5.988$; $d.f.=4,55$; $p<.01$). Contrasts performed using the Newman-Keuls procedure with $\alpha=.01$ indicated that the only two groups that did not significantly differ from each other were the two groups of mestizos. The above result probably represents an education effect particularly in view of the fact that, although many of the individual contrasts were significant at the .01 level, the truly dramatic difference was between the secondary school students and the rest of the groups.

The analysis of variance of number of words of the same semantic class as the stimulus word produced significant group difference ($F=68.138$; $d.f.=4,55$; $p<.01$). The contrasts, (again using the Newman-Keuls procedure with $\alpha=.01$) however, indicated that the only significant difference was between the secondary students and the four other groups of subjects, a result that is clearly consistant with the results of our African studies. (1 & 2)

In summary, the results of our first word association study clearly indicated that overall, the most important effect was due to years of education with the secondary school students being more affected by instructional set, showing higher communality of response, and overwhelmingly giving more responses of the same semantic class as the stimulus word than our other groups of subjects. Within groups our effect, called communality of responses, seems to reflect an educational influence with increased communality occuring as a correlate of increased education. Awareness of semantic class, as measured by the free association technique, also appears to be a clear function of formal education, although there is an indication that there is also an age effect.

Experiments II and III

Introduction

As has been mentioned in the introduction to this series of studies on word association behavior, a number of investigators

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1. A note of caution is advisable here for those who might contemplate, as we did, the use of the free association technique with some measure of set overlap (see Deese 1962) as a means of defining semantic classes. In view of the present results, when working with adults within another culture, strict attention should be paid to the instructions given the subject. Also, the present study indicates that perhaps "semantic class" is not salient except for educated adults which would negate the usefulness of the technique as an ethnographic device.

2. Since there was an apparent age effect for the four groups other than secondary, a separate anova was run without significant results ($F=.797$, $d.f.4,44$, NS).

have reported regular age-related changes in the kind of word association responses emitted by children and young adults (Brown and Berko, 1960; Entwistle, 1966). In general, there is a shift from responses which are in some sense complementary to the stimulus word (red-balloon; run-fast) to words that are of the same form class (red-black; run-walk).

Work by Entwistle (1966) and Rosenzweig (1965) implicates cultural and educational variables, in addition to ages, as important contributors to this "syntactic-paradigmatic shift" as it has come to be called in the literature.

In our own previous work (Sharp and Cole, 1971) we demonstrated that a major difference between Liberian high school students and other young Liberians who had not achieved that level of educational achievement was that the former were more likely to respond to stimulus words from the form classes nouns, verbs, and adjectives with response words of the same form class as the stimulus word than were the latter. The following two experiments were designed to test the generality of these previous findings.

Procedure

Ten subjects from each of the following subject populations served as subjects in Experiment II. (1) six to eight-year old children ($\bar{X}$ age=7.3) enrolled in the first grade of elementary or primary school in the town of Ticul (population roughly 20,000); (2) nine to ten-year-olds ($\bar{X}$ age=9.6) enrolled in the third grade; (3) eleven to thirteen year-olds ($\bar{X}$ age=11.9) sixth grade students; and (4) fourteen to seventeen-year old ($\bar{X}$ age=15.9; $\bar{X}$ grade=8.2) secondary school students, all likewise from Ticul. Subjects were selected haphazardly so that at any time during the course of the experiment roughly an equal number of subjects had been run from each of the experimental groups. The elementary school students were run at school one at a time in a separate room provided by the teaching staff. The secondary school students, on the other hand, were run after school hours in the home of one of our assistants.

Stimuli

The stimuli were eighteen common words, six from each of the three form classes - nouns (knife, plate, pot, bread, tortilla, and trousers), verbs (to eat, to buy, to play, to carry, to run, to climb) and adjectives (large, red, pretty, good, expensive, and tall). Subjects were given the noun form (i.e. nouns with nouns as examples of responses) of the instructions presented above and were again asked to give five response words for each of the stimulus words that they heard. A fixed order of presentation was used for each subject such that a verb followed a noun and was in turn followed by an adjective in the order NVA throughout the list. Subject responses were written down in the order that they were given and then scored as to proportion of responses that were of the same form class (i.e. proportion of paradigmatic responses) as the stimulus word for each form class. The

resulting proportions were transformed using the arc-sine transformation and the results subjected to analysis of variance with repeated measures on form class. Presented in Figure 3 are the results of Experiment II.

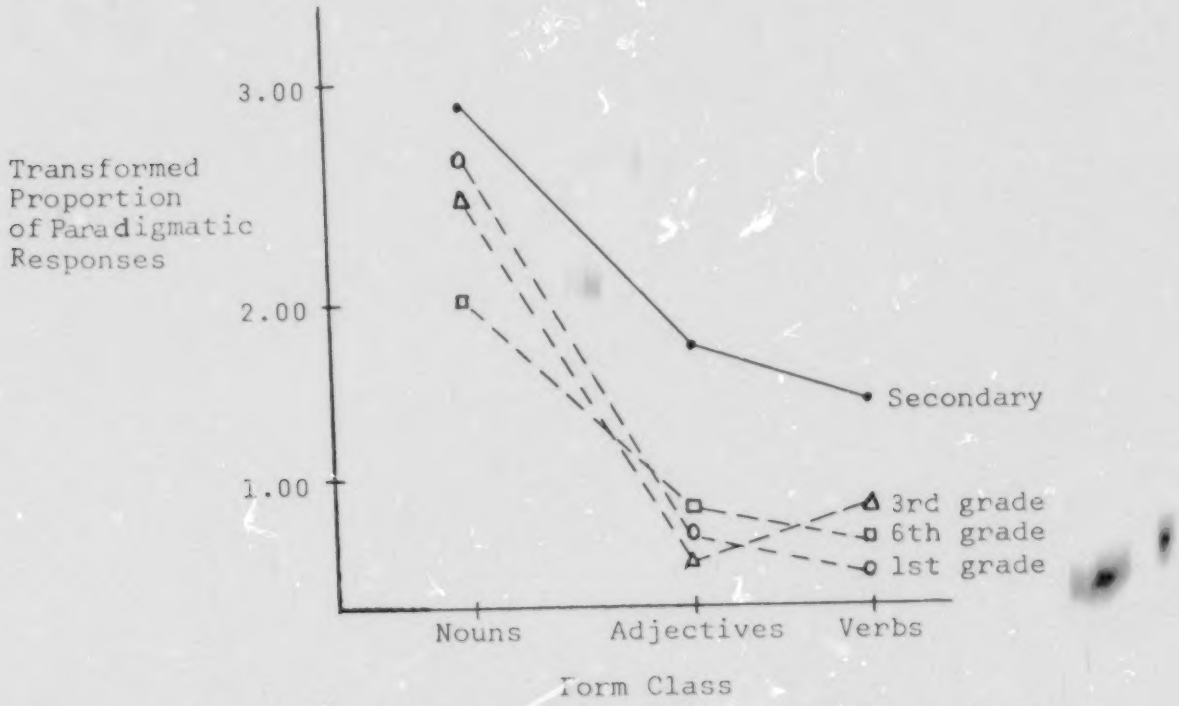

Figure 3. Results of Word Association Experiment II The transformed proportion of within-form class paradigmatic responses is plotted as a function of form class .

Analysis of variance indicated that both main effects were highly reliable as was their interaction ($F_{groups}=7.145$ d.f.$=2,72$ $p<.01$); ($F_{form\ class}=147.73$ d.f.$=2,72$ $p<.01$):($F_{groups \times form\ class}=2.81$ d.f. $=6,72$, $.01<p<.05$.) Individual comparisons run using the Newman-Keuls procedure indicated that the only reliable difference was between the secondary school students and the other three experimental groups. The differences between form classes were all highly reliable with the proportion of paradigmatic responses for nouns being reliably higher than the proportion for adjectives, which in turn were reliably higher than the proportion for verbs.

In summary, the results of Experiment II appear to partially confirm the results of our African studies where it was found that the major change in the pattern of responding (i.e. the so-called syntactic-paradigmatic shift) in word association behavior appears to occur at the secondary school level. The design of Experiment II does not allow us to eliminate age, more broadly than education, as a possible causal factor, however, since there is no group of an age comparable to the secondary school students without their

educational experience. Experiment III represented a partial replication of Experiment II and extended the results of Experiment II to two non-literate populations.

Stimuli and Procedures

The stimuli used in Experiment III were the same group of 18 nouns, verbs and adjectives used in Experiment II. Likewise, the instructional procedure was the same as that employed in Experiment II.

Subjects

The subjects, twelve to a group, were drawn from the following four subject populations: (1) Nine-to-10-year-old ($\bar{X}$ age=9.4) students enrolled in the third grade in Ticul, Yucatan; (2) 14-16-year-old ($\bar{X}$ age=15.8, mean grade=7.8) secondary school students, likewise from Ticul, Yucatan; (3) 20-40-year-old non-literate ($\bar{X}$ age=29.2) Mestizo adults from Ticul and surrounding satellite towns; and (4) 20-40-year-old ($\bar{X}$ age=31.6) non-literate Mayan adults, likewise from Ticul and surrounding satellite towns. Subjects were again drawn haphazzardly, catch-as-catch-can, with the restriction that roughly an equal number of subjects had been run in each experimental group at any time during the course of the experiment. Inspection of the groups employed in the present experiment, and comparison with the groups employed in Experiment II indicate that there are two groups in the present experiment which overlap with the groups employed in Experiment II - specifically the third grade students and the secondary school students, which allows for comparison of results between the two experiments.

Analysis

As in Experiment II, subjects' responses were recorded in the order that they were given, and scored according to proportion of paradigmatic responses for each form class. The resulting proportions were transformed using the arc-sine transformation suggested by Winer (1962) and subjected to analysis of variance. The results of Experiment III are presented in Figure 4. Again, the visual impression given by the figure is confirmed by the results of the analysis of variance. The overall effect for groups is highly significant ($F=13.975$ d.f.=3,44, $p<.01$) as is the overall effect for form class ($F=68.091$, d.f.=2,88, $p<.01$). In addition, the interaction between groups and proportion of paradigmatic responses for the three form classes was also highly reliable ($7=5.526$ d.f. 6,88, $p<.01$) more of which will be said later. Individual comparisons were again run for comparisons among the main effects, using the Newman-Keuls procedure with $\alpha=.01$. For groups, the secondary school students ($\bar{X}=1.0552$) reliably differ from the mestizo and Maya adults ($\bar{X}$ mestizo=1.1264; $\bar{X}$ Mayas=1.0137) which in turn do not reliably differ from each other, but both differ reliably from the third grade students ($\bar{X}=.7652$).

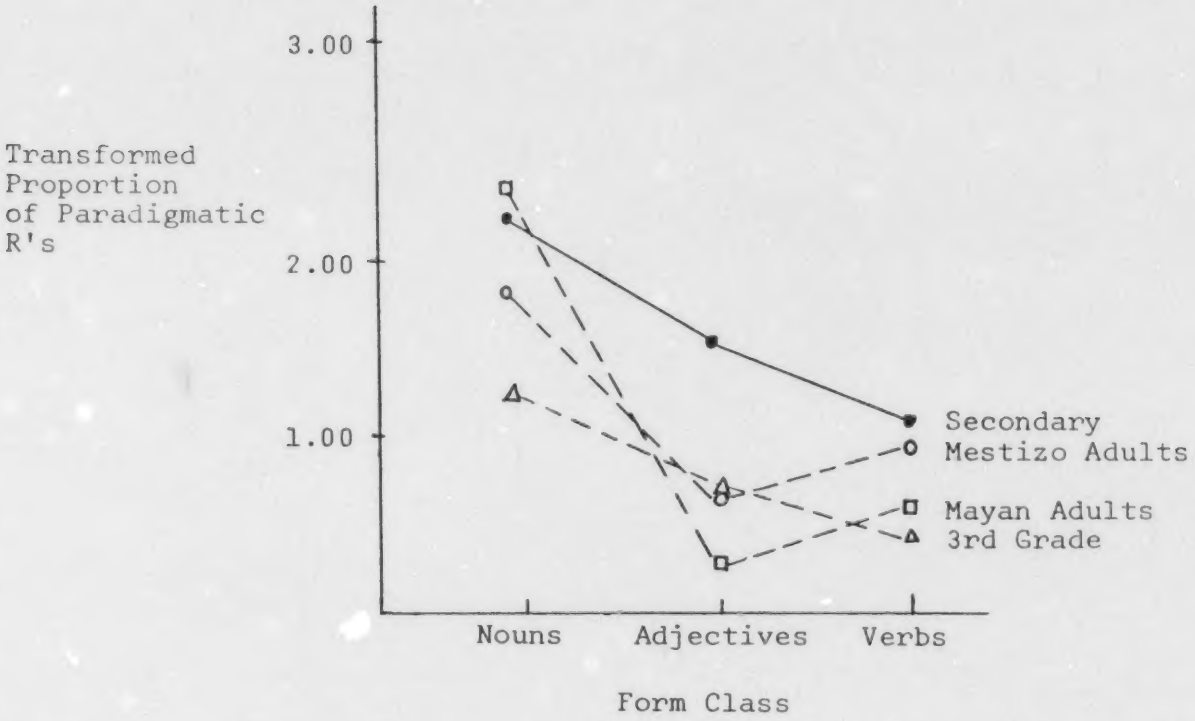

Figure 4. Results of Free Association III

Comparisons in terms of form class indicated that the overwhelming difference was between the proportion of paradigmatic responses to nouns ($\bar{X}$=1.868) and the proportion to verbs and adjectives which did not significantly differ from each other ($\bar{X}$ verbs = .8025; $\bar{X}$ adjectives=.7495). The highly significant Groups by Form-Class-Of-Response interaction reflecting in part the tendency of the two adult groups to give more paradigmatic responses to verbs than to adjectives (while the opposite appears to be true of the school attending groups) has no ready explanation. In studies in the United States and Europe, the pattern of responding appears to be in the order demonstrated by our school-attending subjects. In our African study, however, a reversal of the type exhibited by our adult non-literate groups in the present experiment was exhibited by all of our experimental groups. Whether this apparent reversal is due to linguistic factors, a secondary educational effect of some type, or some other as yet unknown factor, is open to speculation.

In summary, the following appear to be the main results of the word association studies. Experiment I rather convincingly demonstrated that a subject's performance on a word association task can be influenced by the instructional set he carries to the task. Furthermore, more highly educated subjects are more highly influenced. When responding to noun stimuli with a standard set of instructions

using nouns as examples, more highly educated subjects produce response sets of higher communality that are overwhelmingly of the same semantic as well as form class as the stimulus words. In addition, there is a hint in the data that in the production of responses of the same semantic class as the stimulus word there might be an increased tendency to do so with increased age, education apart. Finally, Experiments II and III demonstrated that there is both an age and an education effect in the production of paradigmatic (responses of the same form as contrasted to semantic class) responses, but that the overwhelming difference appears to occur for our subject population between those that have attended secondary school and other groups of subjects.

B. Classification of Real World Objects

A number of investigators (c.f. Greenfield, 1966, or Cole and Scribner, 1974, for summaries) have found that uneducated people are less likely than their educated counterparts to partition groups of objects from different semantic classes along static semantic lines. Operating with poloroid photographs of objects commonly encountered in rural Yucatan, this study sought to determine the influence of education on the tendency to reproduce the potential semantic relations in categorizing behavior.

Subjects

Subjects were drawn from the following four population groups:
(1) 9-12-year-old third grade students ($\bar{X}$ age=11.5) N=20
(2) 12-15-year-old sixth grade students ($\bar{X}$ age=13.15) N=20
(3) Secondary school students ($\bar{X}$ age=16.5, $\bar{X}$ grade=7.85) N=20
(4) Non-literate Mayan adults from Ticul and surrounding towns ($\bar{X}$ age=30.1) N=20

Stimulus Materials

Color poloroid photographs of the following twenty common objects (twelve of which the reader will recognize from the word association studies) were spread out in front of the subject - animals (bull, dog, duck, horse, and turkey); utensils (pot, plate, bottle, cup, knife); food (tortilla, coconut, corn, onion, bread) and clothing (shirt, huipil, pants, sandles, and hat)[1]

Procedure

Each subject was read the following set of instructions in the language in which he felt the most comfortable:

> "I have a group of pictures of things that are very well known to you and to all of us (here the experimenter pointed to the cards that were spread out in front of the subject). What I want you to do is first name the things that appear on the cards for me, then I want you to take the cards and put them in groups that you feel 'go together' or are alike, or are the same in some way. Do you understand what I want?"

1. Words that are underlined overlap with the stimuli used in the free-association studies.

Subjects experienced little difficulty in working with the photographs (a problem that we had encountered in Africa) or in understanding what was required of them. If the subject showed evidence of difficulty, the instructions were read to the subject for a second time. Apparently none of the subjects showed any difficulty after a second reading of the instructions.

Results

For each group of subjects similarity co-occurrence matrices were constructed. This procedure basically entails constructing a n x n matrix, where n are the items under consideration, and the intersects represent the number of times item n_i appeared in co-occurrence with n_j. For our present consideration, $n_i \cap n_j$ represents the number of times that item n_i was sorted into the same group as item n_j. For example, suppose that a subject had produced the following groupings for the five objects (A,B,C,D,E):

[ADE] [BC]

That is, he has produced two piles, or groups, one of which contains the items (ADE) and the other which contains the items (BC). Then the co-occurrence matrix for this subject for this grouping would look like the following:

	A	B	C	D	E
A	-			1	1
B		-	1		
C			-		
D				-	1
E					-

Where item A occurs with items D and E (represented by 1's in the intersects AD and AE), item D occurs with item E, and item B occurs with item C. The final matrix represented the sum of the individual subject matrices for our four experimental groups.

A variety of multidimensional scaling techniques exist for analyzing data of this type, normally referred to as a non-conditional or unconditional similarity matrix. Our results will be presented in two ways. Figure 5 contains a graphic plot of the degree of semantically defined group cohesion. The plot is a combination of the Johnson hierarchical clustering program (an algorhythm that produces a tree diagram of items in a similarity matrix starting from the most specific and proceeding in steps to the most general, Johnson, 1967), and the Torsca non-metric multidimensional scaling program (an algorhythm that places items in a n dimensional Euclidian space on the basis of similarity). Those items that are most similar are placed closest to each other. In theory, any number of dimensions can be selected for the scaling solution up to n-1, where n is the number of items and the solution

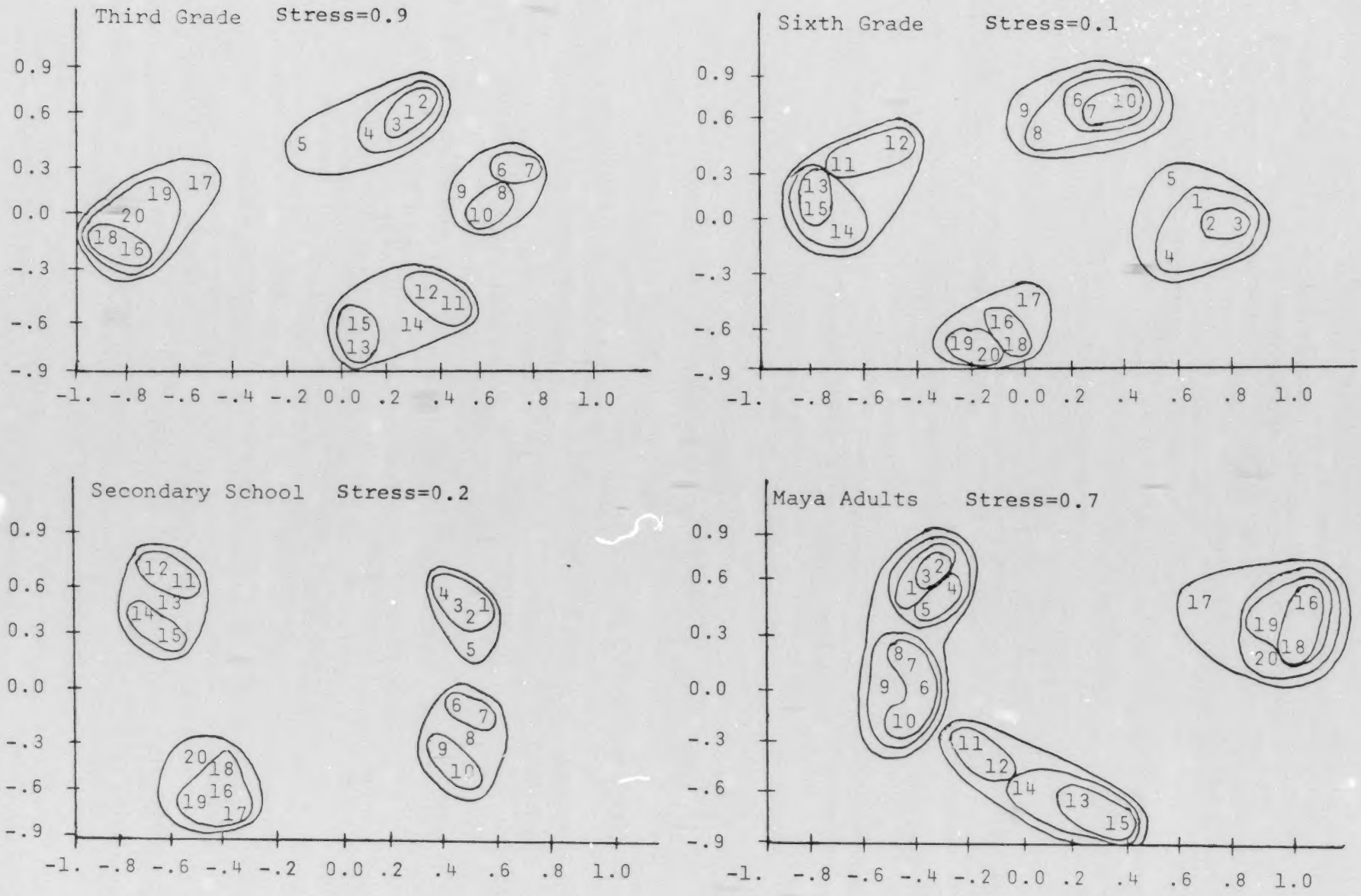

Figure 5. Two dimensional representations of 20 objects used in sorting and memory studies. Items within circles are connected according to Johnson hierarchical clustering scheme

is perfect, 1 dimension for each item. In practice, for reduction of information and ease of presentation some lesser number of dimensions is chosen, and the appropriateness of the solution evaluated in terms of "stress", a number between o and 1 that essentially tells one the amount of "work" the machine had to do to fit the solution of the matrix into the number of dimensions specified - the lower the number the higher the fit, or the more appropriate the solution. We selected two dimensions for the solution of the MDS program, the results of the Johnson hierarchical program (JHCP) are represented by the rings around groups of numbers. Numbers within the circles represent items within a node of a hierarchy. Examination of the stress figures of the four experimental groups indicates that all are less than 0.16, indicating a high degree of appropriateness for the two dimensional solutions. From the figure it appears that all groups respect the categorical structure of the list as determined by prior lexical analysis. However, the cohesion of the respective groups is greater for the sixth grade students and the secondary school students than for the other two groups.

This latter result is more clearly illustrated by an examination of Table 14. In this table we have collapsed across the summary matrices by category and have summarized the total number

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Insert Table 14 about here

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of times that subjects within each subject population placed items from a given category with items from that same or other categories. Inspection of the four panels in the table indicates clearly that the relative proportion of within category sorting is greatest for the two most educated groups and least for the uneducated adults.

Examination of particular entries in the various panels of Table 14 sheds more light on the categorizing principles at work. For the category,clothing, virtually all sorting is within category for all the population groups. But for the remaining categories there is an increasing tendency to combine members of one category with members of another in ways that strongly suggest a functional basis for categorizing that decreases with increasing educational experience. Thus, for example, the Mayan adults are more likely to place a food item and a utensil together than they are to put two food items or two utensils together in a particular grouping. Mixing of food items and animals is also common, although a larger semantic grouping including some of the animals (namely, Duck, Bull, and Turkey) as items in the category food would be a plausible alternative explanation of this result.

While there is a slight tendency to observe the same "errors" among secondary school students and sixth graders, there is relatively little variation among categories for these groups.

Third-Grade Students

	Animals	Food	Clothing	Utensils
Animals	150	66	0	13
Food	xxx	157	6	109
Clothing	xxx	xxx	170	26
Utensils	xxx	xxx	xxx	151

ratio of within category response to between cateogry response=.61
N=20

Sixth-Grade Students

	Animals	Food	Clothing	Utensils
Animals	141	13	0	0
Food	xxx	135	7	39
Clothing	xxx	xxx	190	8
Utensils	xxx	xxx	xxx	144

ratio of within category response to between category response=.90
N=20

Secondary Students

	Animals	Food	Clothing	Utensils
Animals	149	10	16	10
Food	xxx	146	23	51
Clothing	xxx	xxx	154	18
Utensils	xxx	xxx	xxx	147

ratio of within category response to between category response=.83
N=20

Mayan Adults

	Animals	Food	Clothing	Utensils
Animals	275	238	42	81
Food	xxx	280	13	413
Clothing	xxx	xxx	392	31
Utensils	xxx	xxx	xxx	330

ratio of within category response to between category response=.61
N=47

Table 14

Results of picture sorting studies
Number of items sorted together with items of the same or other classes.

Conclusions

These results appear to confirm the findings of other studies about the difference between educated and non-educated populations in their tendency to use static semantic relations to group real world objects. This tendency, however, depends upon the particular relations being studied; all populations use semantic relations in their sorts, the differences appearing in the lesser tendency on the part of the more educated groups to use functional relations among items in addition to semantic ones.

C. Triadic Study of Classification - The Three Words Study

The results of the picture sorting study just discussed seemed to indicate that there was a tendency for less educated subject populations to classify objects more on the basis of functional considerations than their more educated counterparts, who tended to rely more heavily on static semantic classes as their basis for classification. The following experiment sought to investigate the various bases for classification in triadic verbal choice paradigm, where a subject was presented thirty problems, ten each from each of three types. Each problem consisted of three words from which the subject had to either choose the two that were alike (similarities condition) and explain his choice, or choose the one word that was different (differences condition) and explain his choice. Problem types differed in the number of ways the words could be classified and the basis for those classifications. All three problem types had two words that could be placed together, or separated from the third word on the basis of strict semantic considerations. The difference between problem types lay in the relation that the third word in the triad had with the other two. In problem type I, there was minimal or no relation between the third word and the two semantically related words. An example is the following - MACHETE, WATER, AX - where clearly the third word is minimally related to the two tools. In problem type II, the third word had a functional connection with one of the semantically related words, i.e. - HORSE, EGGS, CHICKEN. Finally, in problem type III, the third word was related in a functional manner with both of the semantically related words, i.e. - HORSE, CORN, CHICKEN, e.g.both animals eat corn.

In what follows, the "similarities" and "differences" parts of the experiment will be treated separately for two reasons. Firstly, the differences section had to be completed at a somewhat later date than the similarities section, due to circumstances that were beyond our control at the outset of the series of studies; and, secondly, due to differences in the composition of the Mestizo group (namely, educational attainment) that occurred as a function of the town in which the two groups were run. For these reasons we prefer to treat the "similarities" and the "differences" sections as two different experiments run to a large degree concurrently rather than as one large experiment.

Stimulus Materials

The stimulus materials used in both parts of the present experiment are presented in Table 14, with problem type ((1) no conflicting elements, (2) conflicting elements with one of the semantically based words, and (3) conflicting elements with the two semantic choices) placed following each triad in parenthesis.

Insert Table 15 Here

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[1]	Horse - Beans - Chicken	(1)
[2]	Water - Stone - Posole	(1)
[3]	Rifle - Corn - Hunter's Trap	(1)
[4]	Horse - Eggs - Chicken	(2)
[5]	Machete-Water - Ax	(1)
[6]	Corn - Horse - Beans	(2)
[7]	Horse - Corn - Chicken	(3)
[8]	Water - Salt - Posole	(2)
[9]	Corn - Farm - Beans	(3)
[10]	Rifle - Deer - Sling	(3)
[11]	Machete-Sheath- Ax	(2)
[12]	Corn - Stone - Beans	(1)
[13]	Posole- Stone - Milk	(1)
[14]	Horse - Beans - Goat	(1)
[15]	Rifle - Bullet- Sling	(2)
[16]	Horse - Milk - Goat	(2)
[17]	Posole- Salt - Milk	(2)
[18]	Rifle - Bullet- Trap	(2)
[19]	Machete-File - Ax	(3)
[20]	Rifle - Corn - Sling	(1)
[21]	Corn - Farm - Chile	(3)
[22]	Posole- Gourd Cup-Milk	(3)
[23]	Rifle - Deer - Trap	(3)
[24]	Corn - Stone - Chile	(1)
[25]	Machete-Water - Hoe	(1)
[26]	Corn - Horse - Chile	(2)
[27]	Horse - Corn - Goat	(3)
[28]	Machete-File - Hoe	(3)
[29]	Water - Gourd Cup-Posole	(3)
[30]	Machete-Sheath- Hoe	(1)

Table 15

Stimulus triads used in "Three Words" experiments

General Procedure

Subjects for the "similarities" section were read the following set of instructions:

> "I have here a list of words that I will read you in groups of three words. Of these three words, there are two words that appear the same among themselves in their meaning. Which are they? (First triad inserted) Why?

Subjects for the "differences" section received practically the same set of instructions:

> "I have here a list of words that I will read you in groups of three words. Of these three words, there are two words that appear the same among themselves in their meaning, and one that does not appear the same. Tell me which is that word. (First triad inserted) Why?

Subjects were then read the triads in the order listed in Table 15 one at a time and their choices and justifications recorded. As in previous experiments, all subjects were compensated either monetarily for adults or in kind for children.

Similarities Comparison

Subjects

Subjects were drawn from the following subject populations:

(1) First and second grade students ($\bar{X}$ age=7.5, $\bar{X}$ grade=1.6) N=10

(2) Non-literate Mayan adults ($\bar{X}$ age=34.2) N=10

(3) Fourth and fifth grade students ($\bar{X}$ age=11.7, $\bar{X}$ grade=4.2) N=11

(4) Secondary school students ($\bar{X}$ age=15.7, $\bar{X}$ grade=7.7) N=10

(5) Mestizo adults ($\bar{X}$ age=31.4, $\bar{X}$ grade=3.9) N=10

All subjects were given the instructions as in the "similarities" section and their responses recorded in a data notebook provided for the purpose. Subject responses were coded as "correct" or "incorrect" and subject justifications were coded as to whether they were (1) semantic, i.e. "they are tools," "they are four-footed animals," "they are food," they are weapons," (2) functional, i.e. "they are used to hunt,"

"they are to drink," "they serve to cut" or functional entailment, "the goat gives milk," "the chicken lays eggs," or (3) the specific shared attribute, i.e. "the two are eaten," "the two are drunk," "the two cut," "the two have blades." Note that in many cases the only difference between (2) and (3) above is in the form of the verb, for example, "they serve to cut" is functional or implies a use while "the two cut" implies an attribute or "they are to drink" is a use, while "the two are drunk" is an implied attribute. Thus, the scoring system, except in clear cases such as "the two have blades" or "the two throw" (i.e. a bullet and a stone), relies on nuances in the language and the scorers sensitivity to those nuances. In an attempt to control for this variation, subject protocols were scored by two separate judges, and agreement between the two compared. In general, agreement was almost unanimous except in the case of the Maya subjects, where there was some disagreement based on the significance of some verb forms. Such disagreements were generally resolved after discussion amont the two judges. Finally, if a subject verbalization contained justifications from two categories, i.e. "a tool (semantic) that cuts (attribute) or is used to cut (functional)," both were recorded. Two responses from the same category, i.e. "it is a tool or weapon" were recorded as one.

Presented in Table 16 are the results of the similarities section of the experiment. Column 1 of each of the three panels gives the overall proportion of "correct" choices, that is, choices that were semantically based. Columns 2, 3, and 4 give respectively the proportion of justifications that were respectively semantic, functional, or specific attribute for correct choices. Finally, column 5 is the conditional probability, given an incorrect choice, that the justification was functional. Panel 1 is for problem type 1 (no conflicting elements), panel 2 for problem types 2 and 3 combined (one or two conflicting elements), and panel 3 is the combined data for all three problem types. The first thing to note is that

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Insert Table 16 Here

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when there are no conflicting elements, the proportion of semantically based pairings is very high for all groups. When conflicting elements are introduced, as in problem types 2 and 3, all groups are affected, but the school-attending groups, particularly the fourth and fifth grades, appear to be most affected. Looking next at the proportion of semantic justifications, we see what appears to be an age effect within educational level. The Mayan adults, with little education, are

Table 16

Proportions, choices and type of justification for choosing two "similar" items

	Correct choice	Semantic justification	Functional justification	Attribute justification	P(func)/ Incorrect	Correct choice	Semantic justification	Functional justification	Attribute justification	P(func)/Correct	Correct choice	Semantic justification	Functional justification	Attribute justification	P(func)/ Incorrect	
	No conflicting element					1 conflicting element					2 conflicting elements					
1st & 2nd Grades	.96	.15	.49	.37	1.00	.78	.14	.51	.36	.86	.84	.14	.50	.36	.86	$\bar{X}$ grade 1.6
Maya Adults	.90	.36	.27	.38	.80	.72	.27	.33	.40	.85	.78	.30	.31	.39	.83	$\bar{X}$ grade .6
4th & 5th Grades	.95	.50	.29	.22	.57	.59	.42	.28	.29	.93	.71	.45	.29	.26	.90	$\bar{X}$ grade 4.2
Secondary School	.93	.56	.31	.13	.42	.68	.51	.39	.10	.71	.76	.53	.36	.11	.66	$\bar{X}$ grade 7.7
Mestizos	.94	.59	.21	.19	.40	.79	.61	.22	.17	.74	.84	.60	.22	.18	.67	$\bar{X}$ grade 3.9

superior to the first and second grades; the mestizo adults ($\bar{X}$ grade=3.9) are superior to the fourth and fifth grades ($\bar{X}$ grade=4.2) and roughly equivalent to the secondary school students ($\bar{X}$ grade=7.7). Examination of the conditional probabilities of functional explanations given that the subject makes an incorrect choice emphasizes the difference between the two educated adult groups and the others. The educated subjects' probabilities of making an error for a functional reason are considerably lower than the corresponding scores for the remaining groups. It is interesting to note that this age effect occurs most clearly at about three years of formal education. As we noted above, three years is the minimal level for complete literacy; it is also to be remembered that we saw the hint of a similar effect in the composition of response sets for adults in the first of the word association studies reported above.

Differences Comparison

Subjects

Subjects for the differences study were drawn from the same populations used for the similarities comparisons, but differed considerably in some of their characteristics:

(1) First and second grade students ($\bar{X}$ age=7.6; $\bar{X}$ grade=1.7) N=10

(2) Non-literate Mayan adults ($\bar{X}$ age=34.2) N=11

(3) Mestizo adults ($\bar{X}$ age=36.7; $\bar{X}$ grade=1.9) N=10

(4) Fourth and fifth grade students ($\bar{X}$ age=11.4; $\bar{X}$ grade=4.9) N=10

(5) Secondary school students and highly educated non-school attending adults ($\bar{X}$ age=25.3; $\bar{X}$ grade=8.9) N=10

All subjects were given the instructions as outlined above, and their responses and verbal justifications recorded and scored in the manner detailed above, taking into consideration, naturally, that we were now scoring the reasons why a third word differed from the other two, and not why two words formed a group that was the same or alike. Thus, we expected a great deal more justifications to be based on differences in a single specific attribute since this is all one would need to solve the task, i.e. "this is different from those because it is smaller," whereas functional and semantic justifications imply the additional step of forming contrasting groups. Presented in Table 17 are the results of the differences comparisons.

Insert Table 17 Here

As in the similarities section, it is obvious that the introduction of conflicting functional elements (problem types 2 and 3) hinders the performance of all groups, but in this case, the adults with little or no education appear to be influenced the most. Looking at the proportion of semantic justifications for correct choices on the part of our subjects we see a clear education effect from first and second grade subjects on one end of the continuum to the secondary students and highly educated adults on the other. Of equal interest is the apparent difference between groups in justifications when semantic justifications are not used, i.e. when a function or use or a specific attribute is used to differentiate the third object from the two semantically classifiable objects in a correct choice. Here, it appears for all problem types that the older adult groups, regardless of educational experience rely on specific attributes, while the two elementary school groups tend to rely more heavily on function. That this is generally the case is supported by an examination of the conditional probabilities that a justification would be an attribute p(a)/E or a function or use p(f)E (columns 5 and 6 of Table 17) given a wrong choice among the three objects. Examination of the values in Table 17 clearly indicates that the same groups that prefer functions or uses in their correct choices do the same for their incorrect groupings, while those that prefer differentiation by specific attribute in their correct groupings do the same for the incorrect.

In summary, the two studies in this section appear to confirm an education effect in our subjects' use of semantic classes as a basis for categorization. The result of the similarities section, however, seemed to indicate that there might be an age effect operating along with education, or independently of education. The following study using slightly different materials, but requiring the subject to form groups and justify them on the basis of similarity while controlling more closely for age and education, sought to investigate this relation with a theoretically similar task.

D. Similarities Study # 1 and # 2

One of the sub-tests of the Wechsler adult intelligence scale is very similar to the similarities section of the three words study reported above. Both tests require the subject to form groupings based on perceived similarities of pairs of words, only in the case of the Wechsler scale the subject is presented with only the two words to be grouped - that is, there is no third word from which to choose. The two similarities studies to be reported here used a version of the Wechsler

	Correct choice	Semantic justification	Functional justification	Attribute justification	P(attrib)/Correct	P(func)/ Incorrect	Correct choice	Semantic justification	Functional justification	Attribute justification	P(attrib)/Correct	P(func)/Correct	Correct choice	Semantic justification	Functional justification	Attribute justification	P(attrib)/Correct	P(func)/ Incorrect	
1st & 2nd Grades	.89	.17	.56	.27	.56	.44	.82	.13	.61	.26	.40	.60	.84	.15	.59	.26	.43	.57	$\bar{X}$ grade=1.7
Maya Adults	.85	.20	.04	.76	.77	.07	.68	.24	.12	.64	.68	.30	.74	.22	.09	.69	.69	.26	$\bar{X}$ grade=0.0
Mestizos	.87	.29	.17	.54	.64	.27	.69	.34	.22	.44	.55	.38	.75	.32	.20	.48	.56	.37	$\bar{X}$ grade=1.9
4th-6th Grades	.96	.39	.51	.10	.20	.80	.89	.40	.41	.19	.52	.48	.91	.39	.44	.17	.46	.54	$\bar{X}$ grade=4.9
Secondary & Educ. Adults	.97	.66	.04	.30	.27	.18	.77	.42	.10	.48	.55	.15	.83	.51	.08	.41	.52	.16	$\bar{X}$ grade=8.9
	No conflicting element						1 conflicting element						2 conflicting elements						

Table 17

Proportions, choices and type of justification for choosing two "different" items

similarities sub-test modified to fit conditions in the Yucatan. Experiment 1 sought to investigate more fully the effects that age might have on a subject's ability to form semantic classes, while experiment 2, which was in reality a part of the demographic survey of factors influencing educational attainment reported above, sought to determine if there were variables other than age and education that might have an effect on classification according to semantic groupings.

Similarities Study #1

Stimulus Materials and Procedure

The reader is referred to appendix 3 for a complete description of the procedures, stimulus materials, and scoring procedures used for both similarities matching experiments. Briefly, the subject was read the following list of word pairs in the order in which they are presented below and was asked by E to explain the way in which he thought they were similar or "appeared like one another."

(1) pineapple - banana
(2) corn - squash
(3) machete - hoe
(4) pot - frying pan
(5) horse - goat
(6) watermelon - potato
(7) woman - boy
(8) man - horse
(9) honey - water
(10) fly - tree
(11) gasoline - wood
(12) bicycle - automobile
(13) cedar - mahogany
(14) air - water

Subject responses were then recorded in order in notebooks provided for the purpose.

Subjects

The subjects, twelve to a group, were drawn from the following six subject populations:

(1) 8-11 year-old third grade students ($\bar{X}$ age = 9.83)

(2) 13-15 year-old sixth grade students ($\bar{X}$ age = 13.83)

(3) Secondary school students ($\bar{X}$ age = 13.83 $\bar{X}$ grade = 7.50)

(4) Mayan non-literate adults ($\bar{X}$ age = 50.00)

(5) Mestizo adults with minimal education ($\bar{X}$ age - 27.42 $\bar{X}$ grade = 1.92)

(6) Mestizo adults with 4-6 years of formal education ($\bar{X}$ age = 24.75 $\bar{X}$ grade = 5.33)

To avoid the problems encountered with the "three word study" reported above, special care was taken so that equal numbers of subjects had been run in each group at any given time in the experiment by running subjects from each group in succession regardless of the inconvenience. Subject protocols were scored in two ways. Presented in Table 18 is the proportional analysis analogous to that presented in Table 16 in connection with the three word experiment. Conditional probabilities for errors are not presented, however, since virtually all of our subjects used a specific attribute to differentiate the two items where they said they were not alike. Again the first column

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Insert Table 18 Here

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represents proportion correct, i.e. the proportion that said the items were similar, while the three remaining columns are in turn semantic, functional, or specific attribute for those cases where the subject said the items were similar. The fifth column is the mean score for each group using the Wechsler Adult Intelligence test score (WAIS), about which more will be said presently.

Looking first at the proportion correct and the proportion of semantic justifications we see what appears to be a replication of the three word experiment with there being an increase both in terms of age and education. The final column represents the WAIS score for the same groups, where an individual subject receives a score that is the total of the individual item scores where an item is scored 0 if the subject says there is no relation between items, 1 if the item is justified by a functional reason or a shared attribute, and a 2 if the subject uses a semantic superordinate (i.e. both are animals) or an abstract concept (i.e. both are necessary for life). Thus, for the present experiments subject scores could range from 0 to 28 (the actual range of scores for the present experiment was 0 to 23). The resulting scores were subjected to analysis of variances, which showed that the groups differed significantly ($F = 3.13; d.f. = 5,66, p < .05$). Contrasts, however, using the Newman-Keuls procedure with $\alpha = .01$, yielded no significant differences between groups. In fact, using the Newman-Keuls procedure with $\alpha = .05$, the only significant differences were between the secondary school students and the more highly educated Mestizo adult group and the third grade students. Statistical evidence aside, however, the results of the present experiment taken with those of the

	Correct choice	Semantic justification	Functional justification	Attribute justification	$\bar{X}$ WAIS
3rd Grade	.40	.13	.05	.82	5.33
6th Grade	.42	.20	.20	.60	7.00
Mayan Adults	.38	.23	.32	.44	6.33
Mestizos 0-3 Years Ed.	.50	.32	.27	.42	8.85
Mestizos 4-6 Years Ed.	.53	.50	.24	.26	10.83
Secondary	.54	.48	.12	.40	11.25

Table 18

Responses to Word Pairs

three word experiment reported above, would lend support to the notion that both age and education are working as determining factors in this type of problem, with age being more important than low levels of education, and high levels of education being more important than increasing age. Much, however, could depend upon the manner in which the problem is structured, something that emerged repeatedly in our previous work in Africa (Cole et al., 1971). We will return to consideration of this problem after we consider the results of Similarities Study # 2, the data collected in connection with the demographic survey of factors influencing school attendance.

Similarities Study #2

Stimulus Materials and Procedure

The same materials and procedures were used as those detailed in connection with Similarities Study # 1 above.

Subjects

The subjects used were the same 440 subjects that served as the data pool for the step-wise regression model of school attendance with a mean age of 35.6 (range 16-85) and a mean grade of 3.26 years (range 0-17). The similarities task was administered with instructions and procedures detailed in appendix 1 as the last item on the demographic survey questionnaire. Each subject protocol was scored using the WAIS scoring method discussed in connection with Similarities Study # 1 above.

Results

Over-all scores ranged from 0-27 with a mean of 9. a result that is in high agreement with the results for our adult groups in Similarities Study # 1. The present data lend themselves more to correlational analysis rather than the techniques of analysis of variance. Consequently, the data were subjected to analysis by the technique of stepwise multiple regression with the results presented in Table 19. Only three

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Insert Table 19 Here

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of the twenty variables listed in Appendix 3 were significantly related to the WAIS score and could be considered antecedents rather than consequences. In fact, only one of the remaining variables, modernity, would have contributed significantly to the equation. Modernity clearly cannot be considered antecedent if the WAIS score is to be considered a

Variable	Regression Coefficient	T	B
Sex	1.790	3.5	.15
Father's Occupation	.802	4.1	.21
Grade	.507	5.3	.28

R^2 = .222 Constant = 4.45
Standard error of estimate = 5.22

Table 19

Regression analysis results
Dependent variable = WAIS score

measure of cognitive functioning. The other relevant variables were sex (correlation with WAIS = +.19), father's occupation (correlation with WAIS = +.39), and years of formal education (correlation with WAIS = +.42).

The results presented in Table 19 can best be interpreted, as was the case with years of formal education, by looking at the regression coefficients. These can best be read by saying that a person starts with 4.45 points (constant) receives 1.790 points for being male instead of female, receives .802 points for every step on the six point scale of father's occupation, and receives .507 points for every additional year of formal education. The fact that only 22% of the variance is accounted for by this equation and that the standard error of the estimate is high should advise us to be cautious in our interpretation of the results. One possible explanation is that the WAIS score (which correlates very highly with the entire WAIS test) is indeed tapping an aspect of "native intelligence," something upon which the variables in the equation would presumably have little effect in which case a great deal of the unexplained variance could be attributed to that factor. A far more likely explanation in view of previous work that has been done using the multiple regression technique (C. Lave and J. Müeller, personal communication) is simply that the WAIS score is a poor measure of whatever it is we are measuring. Nevertheless, examination of the B's presented in Table 19 indicates that years of formal education is the single most important factor influencing performance on the present task. The absence of age as a significant determining variable in the present study is probably best explained by the fact that all subjects were adults, the majority with some formal education and that age appears as a significant variable only when education is absent or minimal. (Note three word study and Similarities Study # 1).

In summary, the results of the present study confirm the importance of education as a determining variable in this type of task. Sex as a determining factor has no analogue with our previous work, but will appear again in our discussion of the verbal analogies sub-test of the Thurstone primary mental abilities test. Father's occupation as a determining factor probably reflects some factor or combination of factors such as "richness of environment," but at this point this conjecture represents pure speculation.

E. Category Matching

In the three studies just reported (i.e. picture sorting, three words, and the two similarities studies) evidence emerged for differences between population groups as a function of years of formal education and to a lesser degree for age per se independent of education, depending upon the nature of the task

under consideration. Evidence emerged that the magnitude of this effect depended upon the particular stimulus combination used, with younger and less educated groups being more likely to use non-semantic attributes or functions for classifying when those attributes were available. This effect was particularly evident in the picture sorting study and the three words study where alternative bases for classification were specifically available.

In 1966, Birch and Bortner published a paper directly aimed at the question of categorizing with and without "conflicting" bases for assignment of objects to groups. Their procedure represents a kind of combination of the two studies reported above where possible conflicting bases for classification were specifically present in that they used common objects, but systematically varied the conflicting or non-conflicting nature of the choices presented their subjects.

In view of the fact that comparison data can be obtained from the Birch and Bortner article and the fact that their procedure fits in neatly with the present inquiry into whether age alone, or educational experience, or some combination of the two is responsible for the increasing tendency of older American children (and by extension their Mexican counterparts) to rely more strongly on semantic attributes for stimulus classification, we undertook a replication of the Birch and Bortner study using materials appropriate to the Yucatan peninsula.

Stimuli

Table 20 contains a list of the items used in this "category matching" study. The items are listed in two columns. Those in Series "A" are designed to maximize the conflicting bases on which an item from the triplet on the right could be matched with the single item on the left. Those in Series "B" were selected to minimize such conflict.

Subjects

The subjects were drawn from the five following population groups:

(1) First grade students from Ticul and Bacalar, 42 in Series "A" ($\bar{X}$ age=7.76) and 42 in Series "B" ($\bar{X}$ age=7.95).

(2) Second grade students from Ticul and Bacalar, 38 in Series "A" ($\bar{X}$ age=8.82) and 32 in Series "B" ($\bar{X}$ age=8.72).

(3) Third grade students from Ticul and Bacalar, 26 in Series "A" ($\bar{X}$ age=9.42) and 33 in Series "B" ($\bar{X}$ age=9.45).

(4) Sixth grade students from Ticul, 20 in Series "A" ($\bar{X}$ age=12.95) and 20 in Series "B" ($\bar{X}$ age=13.00)

(5) Non-literate Mayan adults from Ticul, 20 in Series "A" ($\bar{X}$ age=44.05) and 20 in Series "B" ($\bar{X}$ age=46.55)

Insert Table 20 Here

Procedures

Each subject was exposed to either the "A" Series or the "B" Series only. The three "to be matched" items were arrayed on one side of a wooden table in front of the subject. The "criterion" item was placed on the other side of the table. Subjects were then given the following instructions:

> "_____(subject's name). I am going to show you some objects that are very well known to you and to all of us. This game concerns that you tell me which of these objects ought to be with this other that I will show you. I want also that you tell me in whatever sense that you know why you choose as you do. Here you have three objects that are _____, _____, and _____. With which of these three objects should this other go together?"

Subjects experienced no difficulty whatsoever understanding what was required of them.

Results

The results are summarized in Table 21 which shows the mean number of categorical matches (out of a possible score of 4) for each of subject groups and each series along with the percentage of choices which are justified by either a semantic or a functional explanation.

In terms of both dependent variables, there is an increasing proportion of correct responding as function of age ($F=3.87$, $d.f.=4,285$ $p < .01$) with the adults scoring as high or higher than the sixth graders in all cases. The strong visual impression that the "A" (conflicting) Series is more difficult than the "B" Series was also confirmed by the analysis of variance ($F=77.06$, $d.f.=1,285$ $p < .01$). Further evidence that age was the determining factor in the present experiment was provided by with group analysis of the first grade students where the variability of age within grade was unusually high owing to a recent influx of people from

	"A" Series	"B" Series
(1) Palm fiber hat	Shirt (striped) Pot cover Palm fiber bag	Shirt (striped) White thread Small red plate
(2) Small red button	White thread Pepsi bottle top Small red plate	White candle White thread White chalk
(3) Cigarette	White candle Mexican match White chalk	Pepsi bottle top Mexican match Palm fiber bag
(4) Tortilla	Yellow button Sour orange Coffee cup	White candle Sour orange Match

Table 20

Stimuli used in category matching study
(Choices scored as categorical are underlined)

other parts of the peninsula. Here a positive correlation of +.51 was obtained between age and score for the "A" Series. The "B" Series failed to yield similar results but this failure to find an age-related increase in performance is probably attributable to the generally good performance which limits the range of scores.

Insert Table 21 Here

A possible alternative explanation of this age effect is attributed to a high proportion of repeaters (those who would have been exposed to more formal education at the same grade level) in the first grade group. However, examination of school records for the subjects run in Bacalar (90% of the total) failed to support this interpretation.

Discussion

The general trend of these results confirm the findings of Birch and Bortner (1966) although the absolute levels of responding of the Yucatan subjects was below the levels reported for school children in the U.S. Since we used different materials and many other conditions of testing were different, it is difficult to interpret the international discrepancy.

Of greater interest is the fact that this is the first clear-cut case in which age alone, not education, seems to be the important factor in determining the level of performance. We are currently exploring two explanations for the difference between the results with these materials and procedures and the results obtained in the previously reported studies. First, we are carrying out a more fine-grained analysis of the subjects' explanations in the response category we have labeled categorical-functional to bring the analysis of this experiment in tune with the results reported in the other studies above. From the results of the picture sorting study (where pictures were used instead of verbally presented words) we might expect the choices of Mayan adults to be guided more by function than semantic categorical attributes. The scoring scheme used in Table 8 was chosen for the present analysis because it was the one used by Birch and Bortner and we wanted our data to be comparable. But it is not suitable for testing the relation of these results to our previous ones. In addition, we are adding a comparison group at the secondary level because the previous studies have indicated that this might be the level of education where education has an effect independent of increasing age.

Our second line of investigation is to explore the use of the matching procedure in producing more semantically appropriate matches among the Mayan adults than we had anticipated. Unlike the picture sorting study, the conditions for subject choices with a matching procedure are very highly structured and the major elements of the problem are made obvious by the layout of the objects. In a number of cases in our previous work (c.f. Cole, Gay, Glick, and Sharp, 1971, chapter 7) we hav found that population differences associated with education are diminished if the procedures structure the task very explicitly.

F. Categorizing and Re-categorizing with Multiple Criteria

In previous studies, where categorizing per se was the task, a single set of category names could partition the set of alternatives. In fact, use of the category was the only way in which a single set of criteria could exhaustively group the objects. The current studies were directed at instances where several partitions of the set were possible using category names of the same type. We were interested not only in which attributes would be selected as a criterion for sorting the stimuli, but whether or not subjects would sort on more than one dimension.

A number of investigators have found that educated subjects are more likely to use form as a dimension for sorting stimuli, and in addition are more likely to be able to re-sort a set of stimuli once they have attained an initial classification (c.f. Greenfield, 1966; Cole and Scribner, 1974 for summaries and discussions of these data). Relatively few studies have included adults with varying amounts of education in addition to children of school age. For these and other reasons we included a classification/re-classification task in the studies reported here.

Two studies will be described. In the first, all of the stimuli are sets of eight cards. The sets of cards differ only in the dimensions and values of dimensions of the particular stimulus pictures. In the second study, cards depicting abstract forms are compared with a task involving maize.

Study 1

Subjects

Thirty-two subjects from each of four population groups were included in the present study. The groups were:

(1) First grade students (7-9 years of age)

(2) Third grade students (9-10 years of age)

(3) Sixth grade students (12-13 years of age)

	Series A (Conflict)		Series B (No Conflict)	
	% Correct	% Just.	% Correct	% Just.
First Grade	1.8	43	3.0	72
Second Grade	2.0	51	3.4	80
Third Grade	2.5	68	3.4	77
Sixth Grade	2.5	74	3.4	95
Mayan Adults	2.7	80	3.5	99

Table 21

Results of category matching experiment ("% Just" refers to percent of responses justified by categorical reason*)

*Note: The term categorical here includes reasons classified as functional in previous studies to conform to the Birch and Bortner scoring scheme.

(4) Mestizo adults with three years or less of formal education ($\bar{X}$ age=18.4, $\bar{X}$ grade=1.47)

All subjects were drawn from the population of Ticul and surrounding satellite towns.

Stimulus Materials

The stimulus materials were made up of figures colored on the blank side of 3" x 5" index cards with a nylon-tip marker pen. For the first set, the cards varied in color (red vs. yellow), number (1 vs. 2) and form (triangle vs. square). For the second set, the color and number dimensions remained the same, but size (large vs. small circles) replaced form.

Procedures

Subjects were seated opposite the experimenter at a low table upon which one of the set of cards had been placed. He was then given the following set of instructions, which are a variation of the instructions used in the picture sorting study described above:

> "I have here a group of cards with figures on them. (Here the first group of cards was spread out so that the subject could see the figures on the face of the cards). What I want you to do is take the cards and put them into groups or piles that you feel "go together or are alike, or are the same in some way." Do you understand what I want?"

If the subjects experienced difficulty or indicated that they did not understand, the instructions were repeated. If the subject still did not understand after a second presentation of the instructions, he was dropped from the experiment. It was necessary to drop only three subjects, two from the first grade, and one from the third. After the subject had formed his initial grouping, it was recorded by E, the cards removed, and the subject presented with the second group of cards and the instructions were repeated, and the subjects' second grouping recorded. Two cards from one of the stimulus sets were then placed in front of the subject. Cards were selected so that all three dimensional contrasts were present within the pair (i.e. a pair might be two red triangles on one card and one yellow square on the other) and the subject was told the following:

> "Here are two of the cards that you have just put into groups. What I want you to do now is describe to me one of the cards in your own words so that I will be able to pick it out."

The subject's description was recorded, and the procedure was repeated for a pair of cards from the second set of stimulus cards. Finally, one of the subject's initial groupings was reconstructed in front of the subject on the table and the subject was told:

> "This is the way that you put these cards into groups the first time. What I want you to do now is show me if there is another way to put the cards in groups that you feel "go together" or are alike or are the same in some way."

The subject's re-sort was then recorded, and the procedure repeated. Counterbalancing was employed throughout so that half of the subjects received the form set first, the other half the size set. For verbal descriptions each of the four possible pairs of items where the three dimensions appeared simultaneously in contrast appeared an equal number of times and the pairs were counterbalanced for left-right position.

Results

Data for the first sorts are presented in Table 22 in terms of the number of subjects (out of 32 possible in each group) who sorted consistently on one (or more) of the dimensions. Although the most common consistent grouping was for a subject to sort two piles of four cards each along one of the dimensions present in the task, some subjects further sub-divided along a second dimension (i.e. groups of red and yellow, for example, were further sub-divided into red-large/red-small vs. yellow-large/yellow-small). This practice is reflected in the final column - "Total dimensions." The column labelled "Total consistent sorts" indicates the number of subjects in each group who were able to group the cards according to at least one dimension on the first try. The data in this column indicate that the ability to classify either set of these cards increases as a function of grade in school rather than with age per se. There is a clear increase in the total number of consistent sorts over grades, but the Mestizo adults sort at a level consistent with the performance of the third graders.

While there is some suggestion that number and form (where present) are relatively more salient dimensions for older subjects, the data do not support any conclusions

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Insert Table 22 Here

	Color	Number	Form	Total Sorts	Total Dimensions
First Grade	3	1	4	6	8
Third Grade	8	3	7	16	18
Sixth Grade	10	6	17	25	33
Mestizos	4	5	9	14	18

Form cards first sorts

	Color	Number	Size	Total Sorts	Total Dimensions
First Grade	3	2	0	5	5
Third Grade	6	7	4	15	17
Sixth Grade	15	12	8	29	35
Mestizos	3	6	5	11	14

Size cards first sorts

Table 22

First sorts classification re-classification study #1

regarding a color to form or color to number shift in the dominant dimension selected for sorting as a function of either age or education.

To further check on the relationship between the likelihood that a subject can sort his cards at least once and his age or educational experience, a further analysis was carried out with our adult subjects whose educational experience ranged from zero to three years. Combining data from the two card sets, subjects were assigned a score of zero (sorted consistently on neither set), one (sorted consistently on one of the sets), or two (sorted consistently on both sets). Then separate Pearson correlations were run between the number of years of education and age versus the resulting "first sort" score. A significant positive correlation of 0.30 was obtained between educational experience and sorting for our adult subjects. The analogous correlation between age and sorting was not significant.

Analysis of subjects' verbal descriptions of pairs of stimuli indicated that there was a general increase with age in the number of dimensions that a subject mentioned in his descriptions. For the "form" stimulus set all dimensions were mentioned roughly the same proportion of the time for all groups. For the "size" stimulus set color and number were the preferred dimensions for all groups, with size being mentioned only 15% of the time on the average.

The data for subjects' resorting is contained in Table 23. A sixth column has been added to the present table where the conditional probability of a re-sort given a consistent first sort is given. The conclusions that can be drawn from

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Insert Table 23 Here

Table 23, subjects re-sorts of stimuli, are basically the same as for Table 22. The addition of the conditional probabilities (the probability that someone who sorted successfully the first time would be able to re-sort) demonstrates that this ability apparently also increases with years of formal education.

	Color	Number	Form	Total Sorts	Total Dimension	P(r)/S
First Grade	6	0	1	7	7	.14
Third Grade	5	4	4	13	13	.69
Sixth Grade	9	2	8	19	19	.89
Mestizos	3	0	9	12	12	.58

Form cards

	Color	Number	Size	Total Sorts	Total Dimension	P(r)/S
First Grade	5	1	2	8	8	.00
Third Grade	7	4	5	15	16	.36
Sixth Grade	7	3	9	19	19	.95
Mestizos	4	4	4	12	12	.55

Size cards

Table 23

Subject re-sort of stimuli

P(r)/S = Probability (re-sort/sort)

Study 2

This study, a partial replication of Study 1, was conducted to evaluate two additional questions. First, a group of Mayan adults with no educational experience was added to the original study. Second, eight pieces of Yucatec maize were substituted for the size cards used in Study 1. Yucatec maize is red or yellow in color and the kernals vary rather markedly in size, yielding two dimensions comparable to the cards. In addition, some kernals come off the cob as "twins" or "doubles" according to the Yucatec expression. With the exception that the two sets of eight items to be classified consist of cards and corn, instead of two sets of abstract figures on cards, the materials and procedures were exactly the same as in Study 1. The choice of the "corn" or "maize" stimulus objects was prompted by several other studies (e.g. Irwin and McLaughlin, 1970; Gay and Cole, 1967) where it was demonstrated that the use of stimulus objects that were "culturally appropriate" or familiar could enhance performance, or wipe out performance detriments where they existed.

Subjects

Again, the groups consisted of 32 subjects each and were chosen from the following populations:

(1) First grade students from Ticul and surrounding satellite towns (7-8 years old)

(2) Third grade students (9-11 years old)

(3) Sixth grade students (12-13 years old_

(4) Mestizo adults with some primary education ($\bar{X}$ age= 20.7, $\bar{X}$ grade=3.0)

(5) Non-educated Mayan adults ($\bar{X}$ age=34.7)

Procedure

The verbal description of stimulus pairs sub-section was dropped from the present experiment, otherwise all instructions, procedures, and scoring methods remained the same, with appropriate counterbalancing.

Results

The data for the first sorts are shown in Table 24. Panel 1 of the table contains the data for the color/number/form of form set of cards; Panel 2, the data for the corn.

The data from the top half represent a rather neat replication of the comparable conditions in Study 1. In addition,

the Mayan adults sort least of all on any dimension, as would be expected if age rather than educational experience were a critical factor in performance on this task.

Examination of the lower half of Table 10 quickly tells us that using corn, the "culturally appropriate" material, instead of cards does not significantly affect these subjects' ability to sort consistently. The total number of subjects in

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Insert Table 24 Here

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each of the population groups who consistently sort on the first try is virtually identical. Moreover, the number who sort the two comparable dimensions (color and number) is also very similar. As was noted in connection with experiment 1 of this series, there is a tendency for subjects to use more dimensions in their sorts (i.e. more partitions into groups of 2 within two dimensions) that appears to increase with age (a finding that agrees with the results of the verbal description data of experiment 1). Finally, where there was no evidence of a shift from color preference to a form-number saliency in Study 1, the present study offers some evidence of such a shift.

A further analysis of the Mestizo adults' data to assess the relation between number of years of education and sorting yielded a highly reliable correlation of +.66. The larger correlation in this study than in the previous one is almost certainly attributable to the wider range of educational experience in this sample. The data on subject re-sorts are contained in Table 25, and basically confirm the results re-

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Insert Table 25 Here

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ported in connection with Study 1.

G. Learning to Learn Classifications

All of the previous experiments were designed to assess people's ability to classify dimensional or multidimentional stimuli. The question in such studies is whether people come to the situation prepared to classify, and what classificatory principle, if so prepared, they will spontaneously bring to

	Color	Number	Form	Total Sorts	Total Dimensions
First Grade	5	3	3	8	11
Third Grade	8	5	2	12	15
Sixth Grade	7	7	18	22	32
Mestizos	4	8	11	16	22
Mayas	1	1	1	3	3

Form cards

	Color	Number	Size	Total Sorts	Total Dimensions
First Grade	5	1	3	9	9
Third Grade	8	3	3	14	14
Sixth Grade	10	11	3	20	24
Mestizos	7	7	4	14	18
Mayas	4	1	1	6	6

Maize first sorts

Table 24

	Color	Number	Form	Total Sorts	Total Dimensions
First Grade	3	2	2	7	7
Third Grade	2	3	3	7	7
Sixth Grade	7	3	8	15	18
Mestizos	7	6	6	14	19
Mayas	3	1	0	4	4

Form cards re-sorts

	Color	Number	Size	Total Sorts	Total Dimensions
First Grade	4	1	3	8	8
Third Grade	4	2	0	6	6
Sixth Grade	6	4	2	11	12
Mestizos	6	5	6	15	17
Mayas	1	0	2	3	3

Maize re-sorts

Table 25

Resorting cards and maize

bear on different kinds of materials.

The present studies were conducted with a different question in mind: given that the experimenter has selected stimuli which allow for one or more conceptually-based classifications, how long will it take subjects to learn the scheme that the experimenter has in mind? A related question concerns the conditions which underlie improved performance with practice on more than one problem of this type - e.g. will subjects "learn to learn" experimenter-defined classifications? Both of the initial studies reported here are replications of experiments conducted by Sharp among the Kpelle of Liberia (Sharp, 1971; Cole, Gay, Glick, and Sharp, 1971). The third study is the result of questions that arose out of the results of the first two.

Study 1: Learning to Learn with a Constant Relevant Dimension

This study examines the case of learning to learn classifications where the dimension that is relevant to solution remains constant from problem to problem, but the particular attributes that represent the correct responses differ. In such a case, learning to learn may occur either because subjects learn to attend to the correct dimension or because some generalized (associative) skills come into play as the result of practice.

Subjects

Twenty-four subjects were selected from each of the five following population groups:

(1) 4-5 year old pre-school children

(2) 6-7 year old first grade students

(3) 9-11 year old third grade students

(4) 12-14 year old sixth grade students

(5) non-literate Mayan adults ($\bar{X}$ age=36.9)

All subjects were drawn from the populations of Ticul, Yucatan or surrounding satellite towns.

Stimuli

Three sets consisting of eight 3" x 5" cards similar to those used in the classification/re-classification studies were constructed using felt tip marker pens, and were the stimuli used in all the studies reported here. The sets all contained geometric figures that differed in color, form, and number.

The sets differed in attribute values on these dimensions as follows: Set 1 (red/blue, one/two, triangle/square); Set 2 (red/black, two/three, circle/square); Set 3 (blue/black, three/four, triangle/circle). Different stimuli were used in the present studies to make them comparable to the stimuli used in the African studies (see Sharp, 1971 for details).

The order of presentation of stimulus sets was counterbalanced, and the choice of correct attribute randomized with the exception that a given attribute on a given dimension could not occur more than once in a given series of three problems presented to a subject so that the dimension of solution remained constant, but the correct values differed. The stimuli were "sorted" in the same manner as was utilized for the verbal descriptions section of classification-re-classification study # 1 into four pairs such that the cards within each pair varied on all three dimensions (e.g. for set one a pair might be one red triangle vs. two blue squares). Left/right position was counterbalanced, and the four pairs presented in random order with the restriction that a pair could not occur in learning two times in a row. Each subject was fiven the following instructions:

> "I have here a group of cards with figures on them that I am going to show vou two at a time (here the experimenter held up one of the sets of cards and placed them haphazardly on the table for the subject to see). Each time I show you two of the cards I will be thinking of one of them. I want you to tell me which of the cards you think I am thinking of. If you are correct I will say "yes," if you are wrong, I will say "no." Try to be correct as often as possible. Do you understand what I want?"

Training was continued until the subject was able to identify the correct choice for ten trials in a row or until 40 trials had been administered and the subject made his first error. only one subject failed to reach criterion on one of the problems. A sorting task was introduced following learning, about which more will be said later.

Results

Figure 5a illustrates the performance of each group for each of their three problems, averaging over particular dimensions and attributes. An analysis of variance supports the visual evidence that all groups improve across problems ($F=7.93$; $d.f.=2,230$; $p < .01$), and that there is a general improvement in performance as a function of age and education ($F=47.09$; $d.f.=4,115$; $p < .01$). The interaction between the two was not reliable ($F=\approx.50$, n.s.). Individual contrasts using the Newman-Keuls procedure with $\alpha=.01$ indicated that the two oldest groups, the sixth graders and the Mayan adults are not different

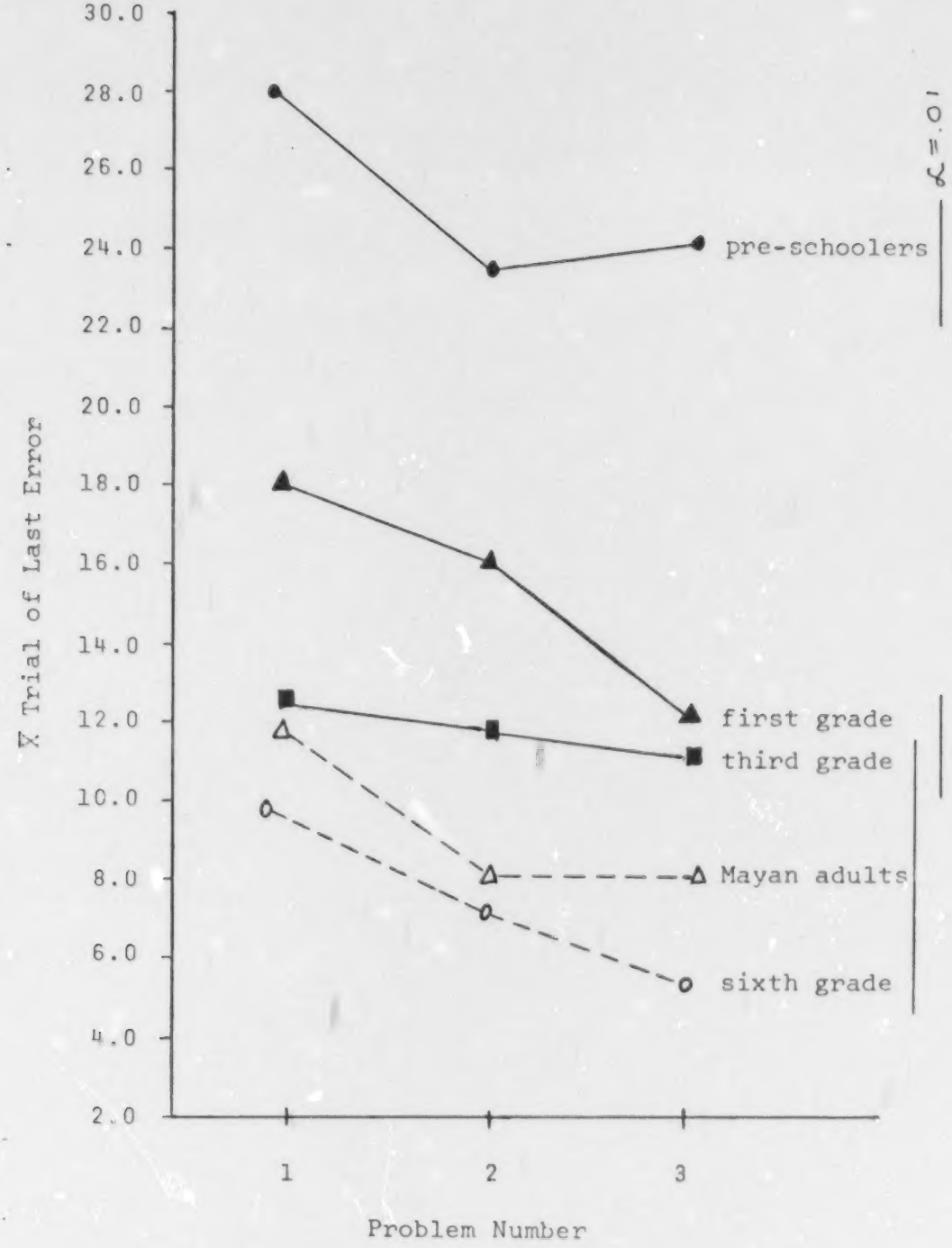

Figure 5a Groups x Problems: Study 1

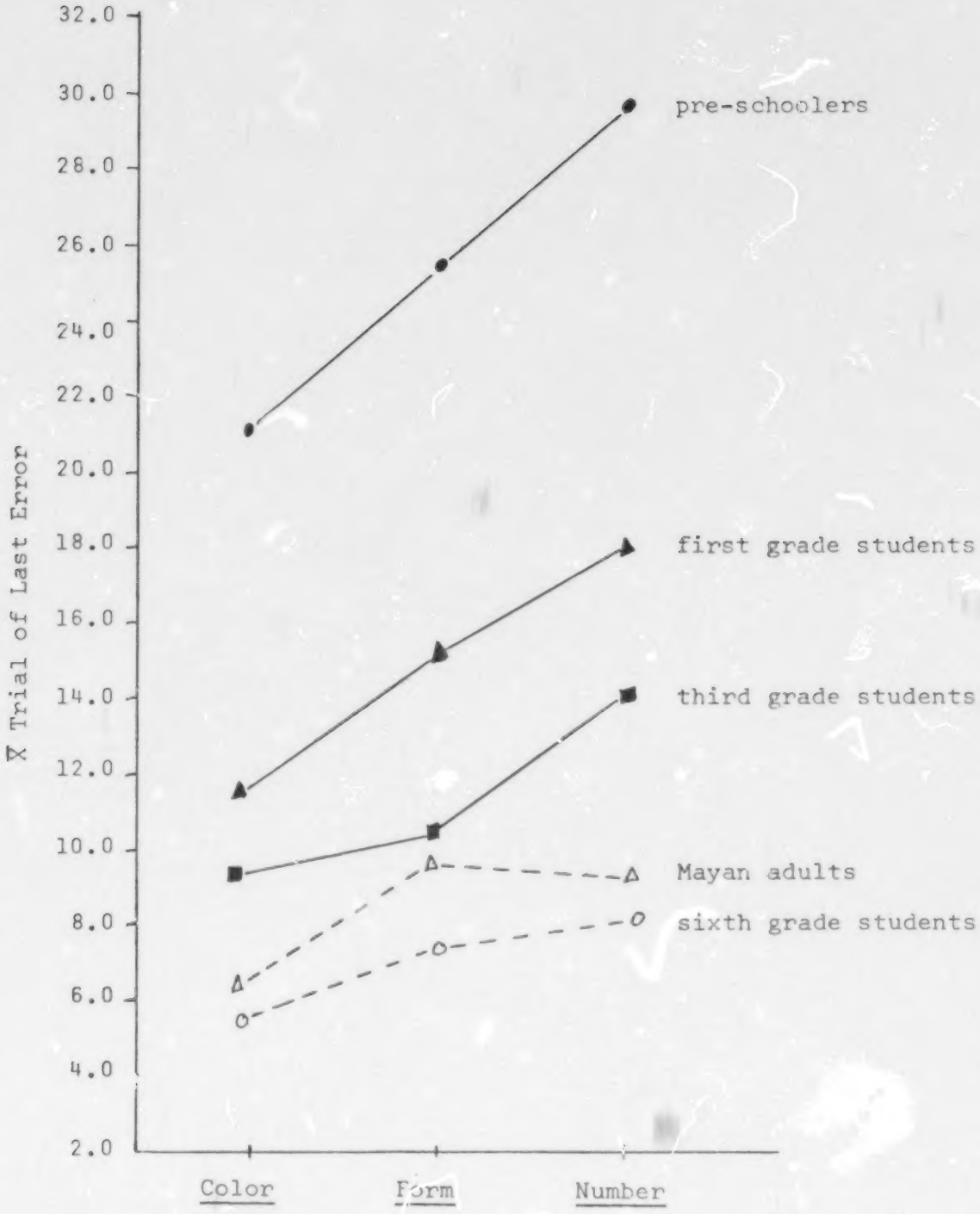

Figure 5b Groups x Dimensions: Study 1

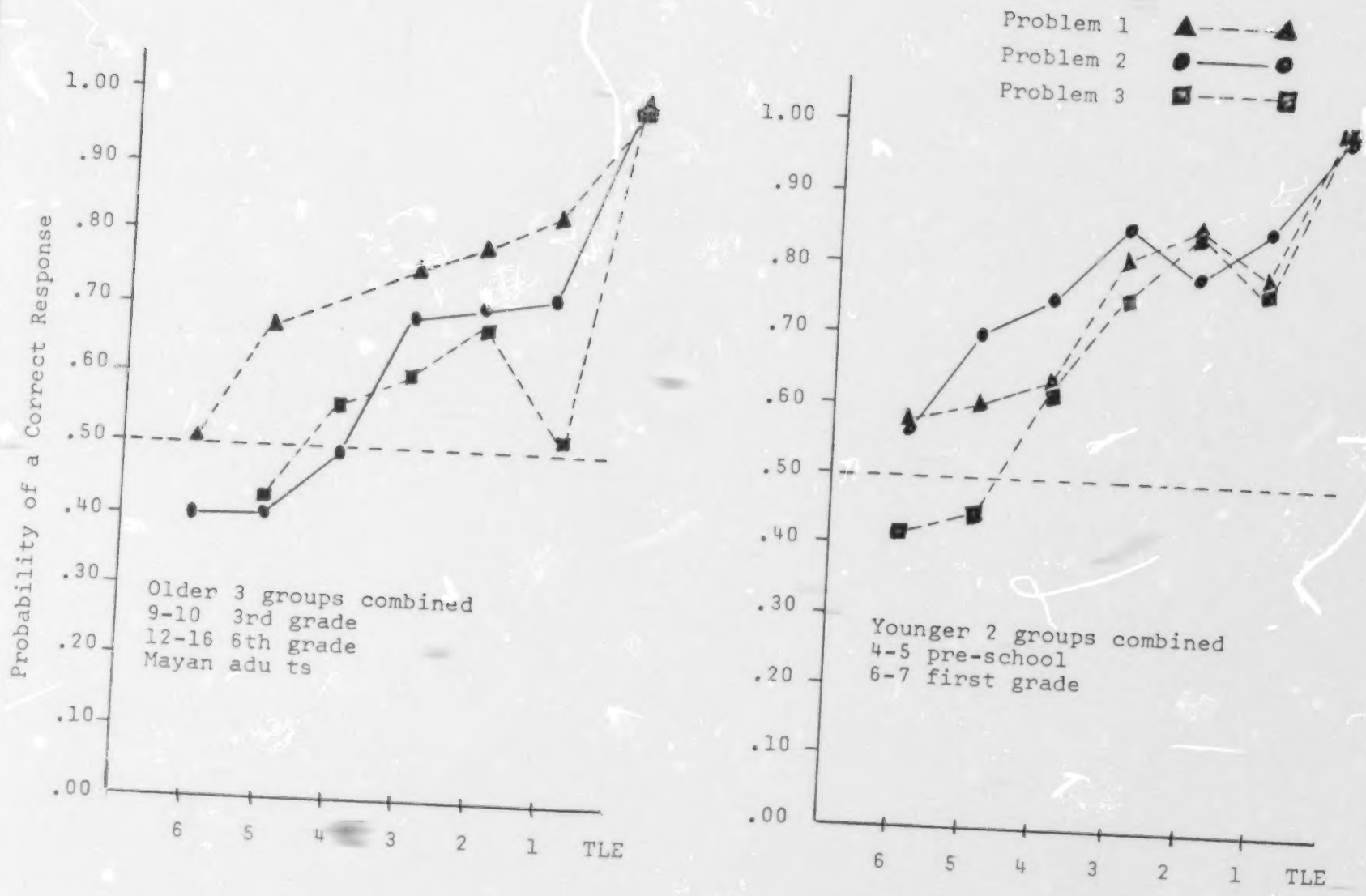

Figure 5c - Backward Learning Curves Study 1

from each other, but superior to the other groups which line up in order of age/grade. Figure 5b shows the results of the same experiment with stimulus dimensions in training as the independent variable summed across problems. Again the visual impression is confirmed by analysis of variance - that is, dimensions differ significantly in the speed with which they are learned ($F=11.25$; d.f.$=2,105$; $p < .01$). The interaction between groups and stimulus dimensions was not reliable ($F=0.62$; d.f.$=8,105$; N.S.). Individual contrasts run using the Newman Keuls procedure indicated that all dimensions differed significantly from each other in the order: number ($\bar{X}=16.02$) was more difficult than form ($\bar{X}=13.98$), which in turn was more difficult than color ($\bar{X}=10.86$). The main point of the experiment, however, is contained in Figures 5a and 5c. While it is clear that all groups show improved performance between problems 1 and 3, results obtained by Sharp in Liberia suggest that the kind of improvement from problems 1 to 3 observed in this experiment would be associated with a pattern of pre-solution performance reflecting a search for stimulus dimensions, rather than rote recall of particular correct responses. In brief, he argued that subjects who attended selectively to particular stimulus dimensions in attempting to solve these problems would respond at a chance level until they discovered the correct answer, after which their performance would jump to 100% correct. On the other hand, subjects who simply learned specific correct answers ought to start responding at chance, but gradually improve their performance as they learned particular pairs. Just prior to solution their error rate ought to be somewhat less than 25% (i.e. one of the pairs not learned, but occasionally guessed correctly).

The data relevant to this kind of "process interpretation" of performance on this task are shown in Figure 5c. (For a more complete discussion of the logic of this analysis see Zeaman and House, 1962). For reasons that are discussed below, the data in Figure 5c are presented in two panels, one for the two youngest groups, and one for the three older groups. The "backward learning" curves from the trial when the last error occurs is shown separately for each problem. The main point to notice is that for the two youngest groups (the right-hand panel) performance gradually improves prior to the last error for all these problems, terminating right in the area expected if the subjects have learned three of the pairs and are wrong owing to a poor guess on the trial just prior to learning the final pair.

This same pattern of performance is obtained for the older groups on the first problem, but by the third problem, performance just prior to the last error is almost exactly at chance (.53).

Thus it appears that the reasons underlying performance improvements with practice may be the result of two different processes at work. For the older subjects it appears that there is a shift from learning specific correct answers to learning dimensions. We cannot be sure what mechanisms are at work with the younger children, but whatever they are, they seem to result in the faster rote learning of specific stimulus-response relations rather than a shift from rote remembering to concept/dimension based learning.

This latter interpretation is supported by evidence from an experiment published by Cole (1973) as a part of this project. The Cole study will not be described in detail since it does not contain an adult group, and hence is not directly relevant to the main focus of this report. However, Cole does report discrimination learning and transfer data indicating that in the age range from 4-10 with children from the same populations as used in the present study, there is a gradual shift to concept-based learning that exactly parallels the results reported here.

One more result need be reported in connection with Study 1. It will be recalled that it was mentioned in connection with the procedure that a sorting task similar to that reported above was introduced following learning. Presented in Table 26 are the results of that task. The procedure was the same as reported in connection classification/re-classification studies with the exception that each subject received only one of the stimulus sets (each set appeared an equal number of times for each group, that is to say, eight) and was only asked to sort the set once. The results are very clear-cut. First, the number of successful (out of 24) sorts is very high for all

groups with the exception of the pre-school children (the three school-attending groups sorted perfectly), and the number of dimensions used (i.e. the number of sorts on more than one dimension) appears to increase with education as was noted before. The fact that different stimulus materials were used in the classification studies and in the present experiment does not permit us to make a definitive statement about the effect of discrimination learning training on classification, but it is certainly one alternative explanation of the differences in absolute levels of performance between the two previous studies and the present one, especially when one notes the number

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Insert Table 26 Here

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of sorts that employed the dimension upon which the subjects were trained.

In summary, it appears that educational exposure is not critical in controlling the rate and manner of learning rather simple classification problems of the kind studied here. We cannot be sure from the evidence we have whether or not education has some influence on performance; a straight extrapolation of the results based on age as a critical variable would lead us to expect better performance by the Mayan adults than the sixth graders, yet the results are in the opposite direction. It seems plausible that secondary school students could learn these problems in less than the average of about 6 trials reached on problem 3 by the Mayan adults and sixth graders. Probably the safest course is to conclude that both age and education can influence performance on this task.

Study 2

The major point of the first study was to retain a particular dimension as the "correct one" and to determine if subjects would come to use this potential information in learning. The present study sought to determine what part, if any, of the improvement from problem to problem in Study 1 is the result of increasing familiarity with the situation or other, generalized factors, rather than skills directly related to dimensional learning. This shift in focus is realized in the current study by shifting the dimension of solution between problems.

Groups of 24 subjects each representing each of the populations included in Study 1 were included in this study. In addition, two groups of 24 subjects each (secondary school students and 8-10 year old non-literate Mayan children) not included in Study 1 were added to the present study so that higher levels of education were represented, and a non-literate group of strictly comparable age with one of the educated groups was

	Number of successful sorts (24 max.)	Total using training stimulus dimension	Color	Number	Form	Total dimensions used by subjects
Preschool	14	14	7	3	6	16
Mayan Adults	20	16	10	7	10	27
First Grade	24	18	12	3	13	28
Third Grade	24	19	11	6	15	32
*Sixth Grade	24	22	10	9	17	36

Table 26

* Data not available at time of typing

also included. Procedures, criterion, and scoring methods were the same as those employed in Study 1 with the exception that subjects were not asked to sort after the completion of discrimination learning. Each subject received three problems, one from each of the three stimulus sets, with a different dimensional basis for solution on each problem, and dimensional basis for solution was counterbalanced across problems.

The results, presented graphically in Figures 6a and 6b, are difficult to interpret clearly. Figure 6a clearly indicates a lack of problem to problem improvement. In fact, the effect is in the opposite direction (over-all mean problem 1=7.21, problem 2=8.58, problem 3=9.08). Both this and the dramatic groups effect were confirmed by analysis of variance (F groups=37.44; d.f.=6,119; $p < .01$)(F trials=4.70; d.f.=2,238; $p < .01$). The groups by trials interaction, however, was not statistically reliable (F=.51; d.f.=12,238; N.S.). Turning to Figure 6b, a separate analysis of variance indicated that both the over-all dimensions effect (F=37.99; d.f.=2,238; $p < .01$) and the interaction between groups and dimensions presumably effecting the difficulty that the two younger groups have with dimensions other than color (F=2.43; d.f.=12,238; $p < .01$) were also highly reliable. Individual comparisons were again run using the Newman-Keuls procedure with α=.01 with the following results. For the groups comparison the 4-5 year old pre-school children and the first graders differed reliably from each other and from all of the rest of the groups, the Mayan adults and the sixth grade students did not differ reliably from each other, but differed reliably from the remaining groups, which in turn did not differ from each other. In terms of dimensions, the contrasts indicated that the only significant difference was between color and the other two dimensions which in turn did not reliably differ from each other.

Comparison of the population groups fails to yield clear evidence of either a consistent ordering by age or by years of formal education. To be sure, the five year olds and first graders and totally uneducated Mayan 8-10 year olds do as well as secondary school students, and better than either sixth grade students or Mayan non-literate adults.

Analysis of the backward learning curves for the groups in this experiment indicated that for all groups on all problems there was gradual improvement from chance to approximately 75% correct responding on the trial just prior to the last error indicating that some form of associative process is at work in this type of problem.

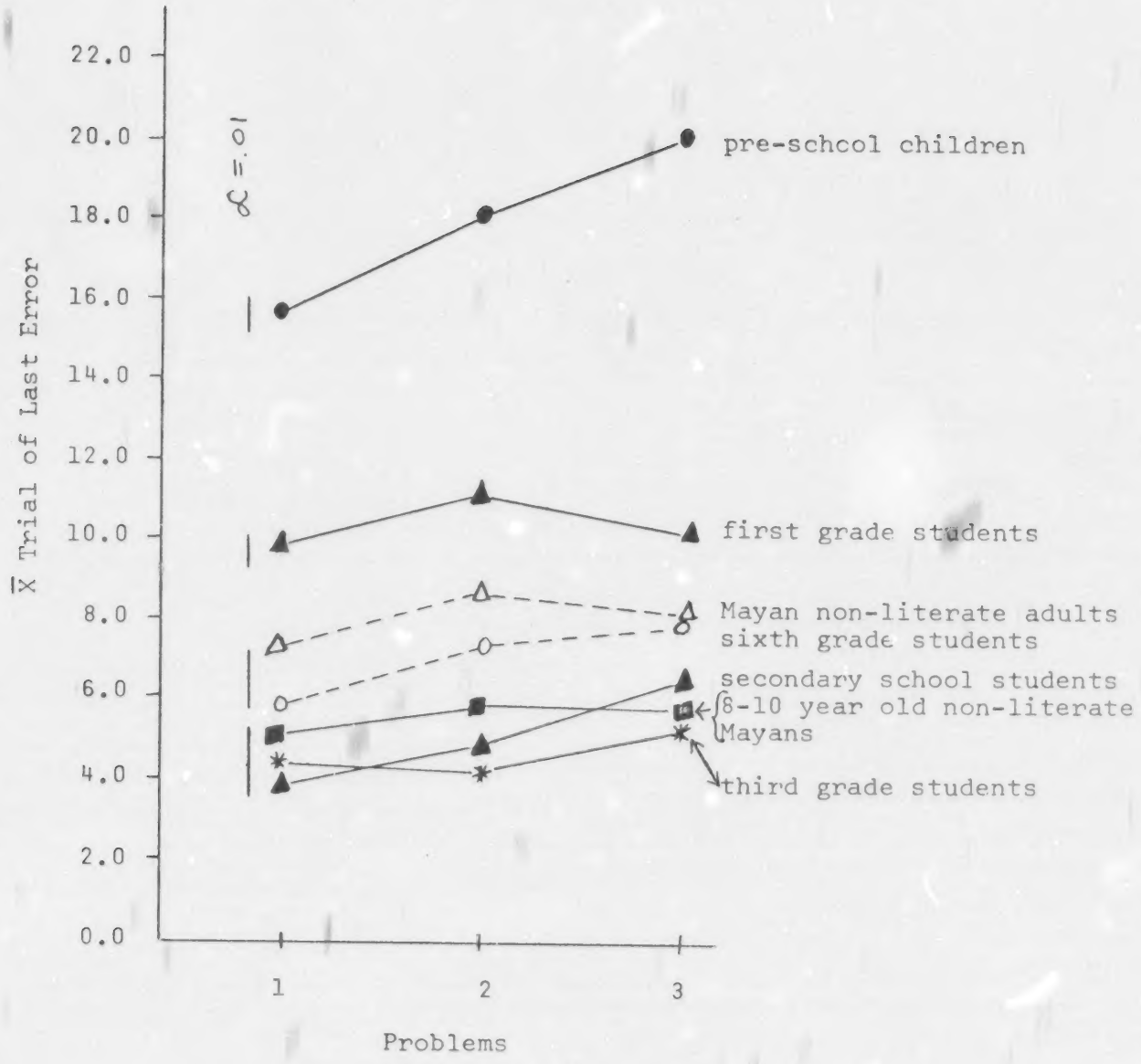


Figure 6a - Analysis by Trials Study 2

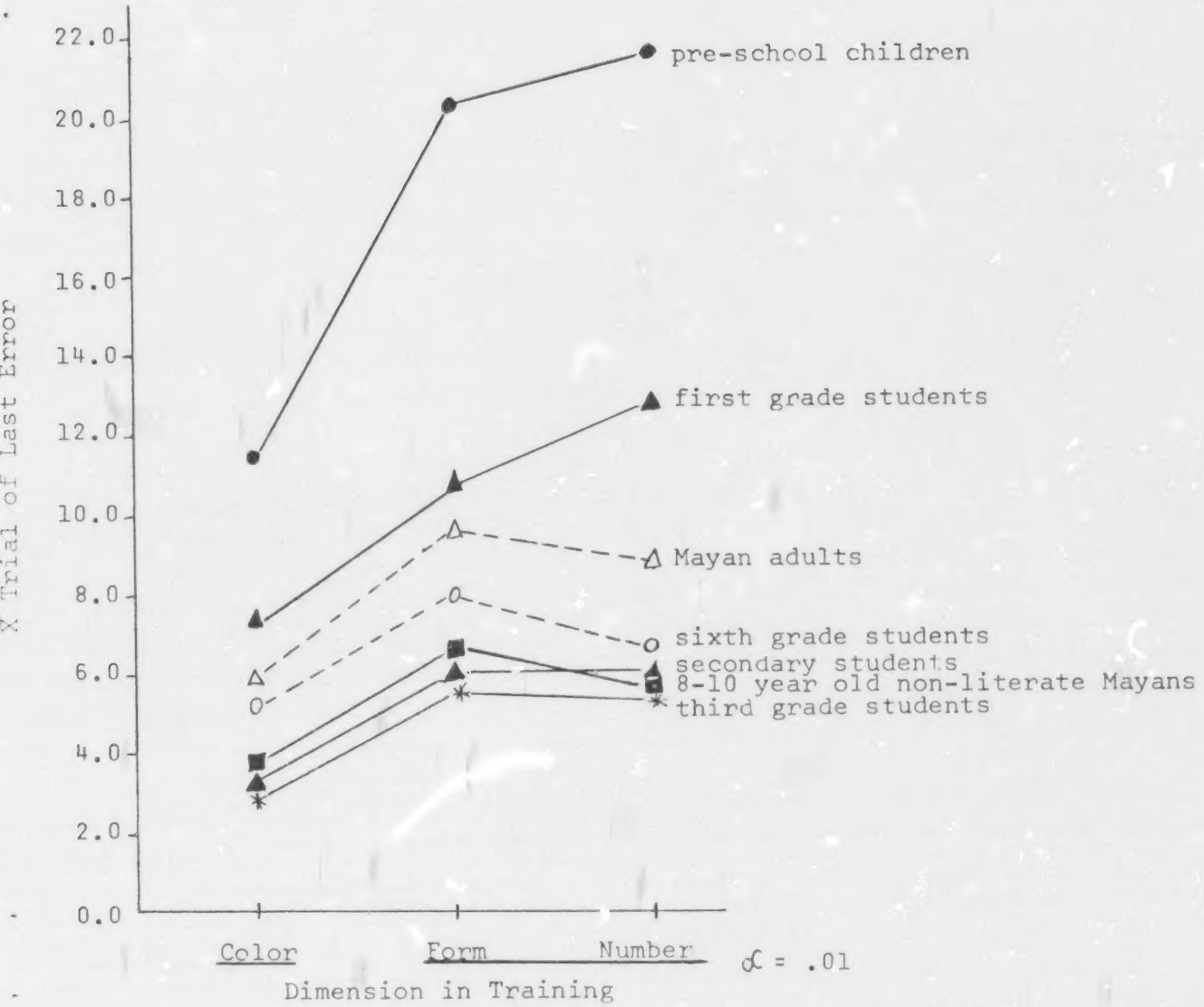


Figure 6b - Analysis by Dimensions

Study 3

Prompted by the fact that we could obtain no clear ordering by either age or education as dimensions in Studies 1 and 2, we turned in Study 3 to a situation in which we could vary one factor while we held the other as near constant as possible. In this case we worked with young adults 15 to 26 years of age and held their ages constant while varying their average education. An additional consideration, that was of equal importance to us, was that all subjects in Study 2 had failed to show improvement from problem to problem in the task and had demonstrated backward learning curves that suggested an incremental learning process of some type at work. We simply wanted to see if this picture would change at the highest level of education that was available to us and consistent with our over-all sample.

Subjects

Subjects were from the following subject populations:

(1) 16-26 year old Mestizo adults ($\bar{X}$ age=23.08) from Ticul who had had either one, two, or three years of formal education ($\bar{X}$ grade=2.42). N=12

(2) 17-26 year old Mestizo adults from Ticul ($\bar{X}$ age=23.16) who had had 4-6 year of formal education ($\bar{X}$ grade=4.75). N=12

(3) 15-23 year old students from Ticul ($\bar{X}$ age=18.29) enrolled in grades 9-13 in secondary school. N=18

Thus, it can be seen that the two Mestizo groups are of virtually the same age and vary only in the amount of formal education they have had. The students have considerably more education and are younger - age in the direction opposite from that predicted for an age effect.

Procedure and Stimulus Materials

The procedures were the same as reported for Study 2 above with the same three sets of eight stimulus cards each being employed.

Results

Results are presented in Figures 7a and 7b. As can be easily seen, for the first time we have a clear ordering on the basis of educational experience. This visual effect was supported by analysis of variance ($F=10.03$; $d.f.=2,39$; $p < .01$). Individual comparisons using multiple t-tests, however, indicated that the only significant differences were between the two more highly educated groups and the less educated group. Effects by trials and by dimensions were in the directions expected for the less educated group, but were non-reliable. Less one should jump too

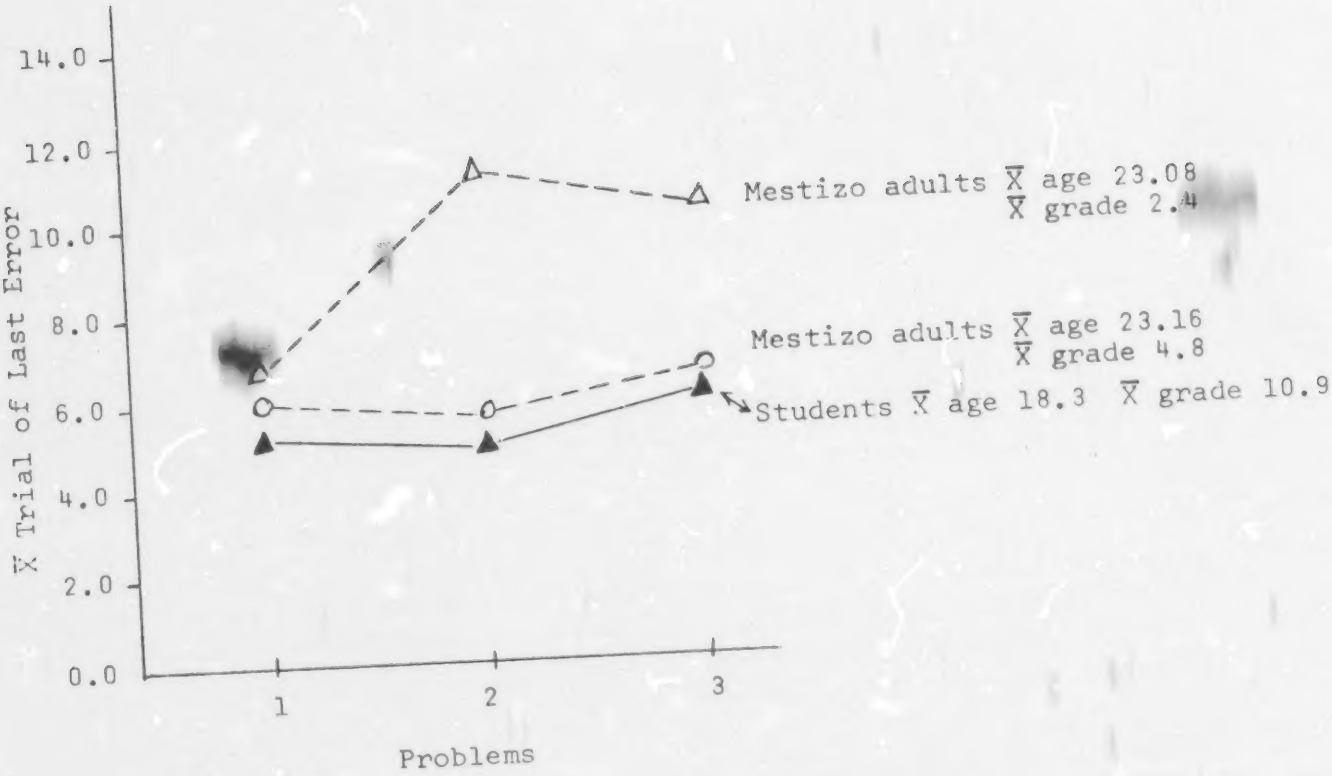
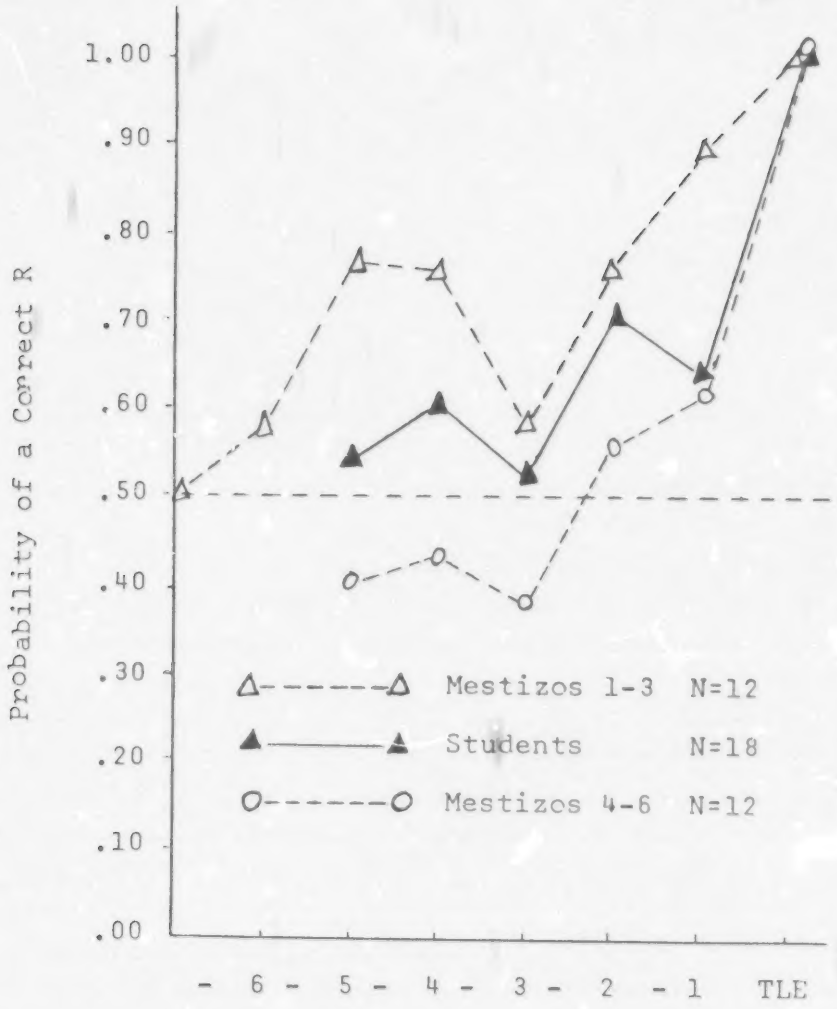


Figure 7a

rapidly to conclusions, it should be noted that comparison of the present results with Figure 6a above places the Mestizo adult group with less education in the same region as the non-literate Mayan adults and first grade students, the other Mestizo group with the sixth graders, and our highly educated students right with the third graders, non-educated Mayan 8-10 year old, and secondary school students of Study 2. Presented in Figure 7b are the backward learning curves for the three groups in the present experiment. As can be easily seen these data, averaged across all three problems, can be argued either way for the two more highly educated groups, but over-all, and in view of the results of Study 2, support more fully the notion that an incremental process is responsible.



General Discussion

Taken together, these studies would appear to indicate that increased educational experience does not play a critical role in simple concept learning for these population groups for the kind of abstract figures used in this study. This general conclusion cannot be substantially strengthened without further work. The differences in pre-solution behavior between the groups in Study 1 and between comparable groups in Studies 2 and 3 clearly implicates the presence of a common dimension across problems as a factor in inducing the older subjects to learn more rapidly and apparently in a manner that makes use of the conceptual dimensions latent in the stimuli. It is our intention

now to concentrate on two or three critical population groups and to explore such factors as the number of stimuli that must be learned, the number of dimensions present, and the number of different problems given as practice in an attempt to tie down more precisely the factors underlying the shift to a conceptual pattern of classification learning and learning to learn.

H. Memory

Several studies carried out in Liberia have suggested that school attendance is an important factor contributing to the use of kinds of memory skills routinely studied in American laboratories (c.f. Cole et al., 1971; Scribner, 1974a). However, the importance of education in the development or application of "higher order mnemonic skills" has been questioned in research reported by Kagan and his associates (Kagan and Klein, 1973) working with Mayan groups in rural Guatemala.

Although the studies conducted by both groups of investigators shared roughly the same general methodology (recall of common nouns or objects presented orally or displayed in some physical manner), there were variations in details of method and the range of educational experience (to say nothing of many cultural variables) which make evaluation of the differing conclusions extremely problematic.

The experiments to be reported here serve to narrow the gaps in previous research on the relation between educational experience and the development of memory skills.

H_1. Short Term Memory

As a part of the present project, a simple and easy to administer short term memory task, first introduced by Macoby and Hagen (1965) was conducted by Daniel Wagner of the University of Michigan. This research is described in considerable detail in Wagner (1974), but its main points will be summarized here because they are an integral part of the pattern of results obtained in this project.

Using pictures of animals and common domestic objects taken from the popular Mexican game of lotteria, similar in nature to American bingo, Wagner constructed sets of stimuli on 1 1/2" x 3" cards where each card contained a picture of an animal and a picture of a domestic object. A given set contained seven animal-object pairs and a "probe" card which contained a picture of an animal or an object. The basic task was for the subject to remember the position of an animal (for half the subjects in each group) or an object (for the remaining half) after the cards had been laid out in a linear arrangement with two seconds for observation of the position of each card. The

probe trials were selected to probe each of the seven possible positions in a random order. Since the cards were always laid out from the subject's left to his right, the position of the probe also determined the delay between presentation of a card and the test for recall of the position of the card.

The subjects in this study were selected from five different age ranges: 7-9 years, 10-12 years, 13-16 years, 20-21 years, and 22-35 years. Unlike the other studies thus far reported, Wagner attempted a systematic investigation of the influence of urbanization on the development of cognitive performance by selecting roughly half of the subjects from the small, relatively traditional Mayan town of Mayapan and the other half from the capital city of Merida. The Meridians, except for the two youngest age levels, had experienced considerably more years of schooling than the rural Mayans.

The major result of this study for our purposes is shown in Figure 8, which plots the proportion of correct recall responses as a function of age and urbanization. Statistical analysis revealed that only after educational levels diverged (age 13-16 years) did the performance between urban and rural groups differ, although the difference that did exist was in the predicted direction. Thus it appears that what Wagner observed was basically a difference in short term memory performance owing to the increased efficiency of the more educated subjects and the absolute lack of improvement on the part of older subjects who had not been to school.

More detailed analysis of the pattern of responding as a function of the delay between presentation of a card and the probe for recall indicated that the major difference was concentrated on the items tested with the longest delay period. On the basis of previous research in the U.S. Wagner interpreted this finding to mean that the more educated subjects engage spontaneously in active rehearsal for the purpose of remembering, while the less educated subjects will fail to rehearse or rehearse ineffectively.

These results, as well as others included in Wagner's report rather clearly differentiate educated and non-educated subjects at or above the 8th grade level. We would suggest that the seeming discrepancy between Kagan and Klein's results and Wagner rests in the fact that Kagan and Klein restricted their studies to younger children who had been exposed to relatively few years of education. The next study will bear on this same point.

H_2. Free Recall

In our monograph on culture and cognitive performance (Cole et al., 1971 pp. 259-262) we reported pilot work with Yucatecan subjects from Ticul which tended to support the Kagan

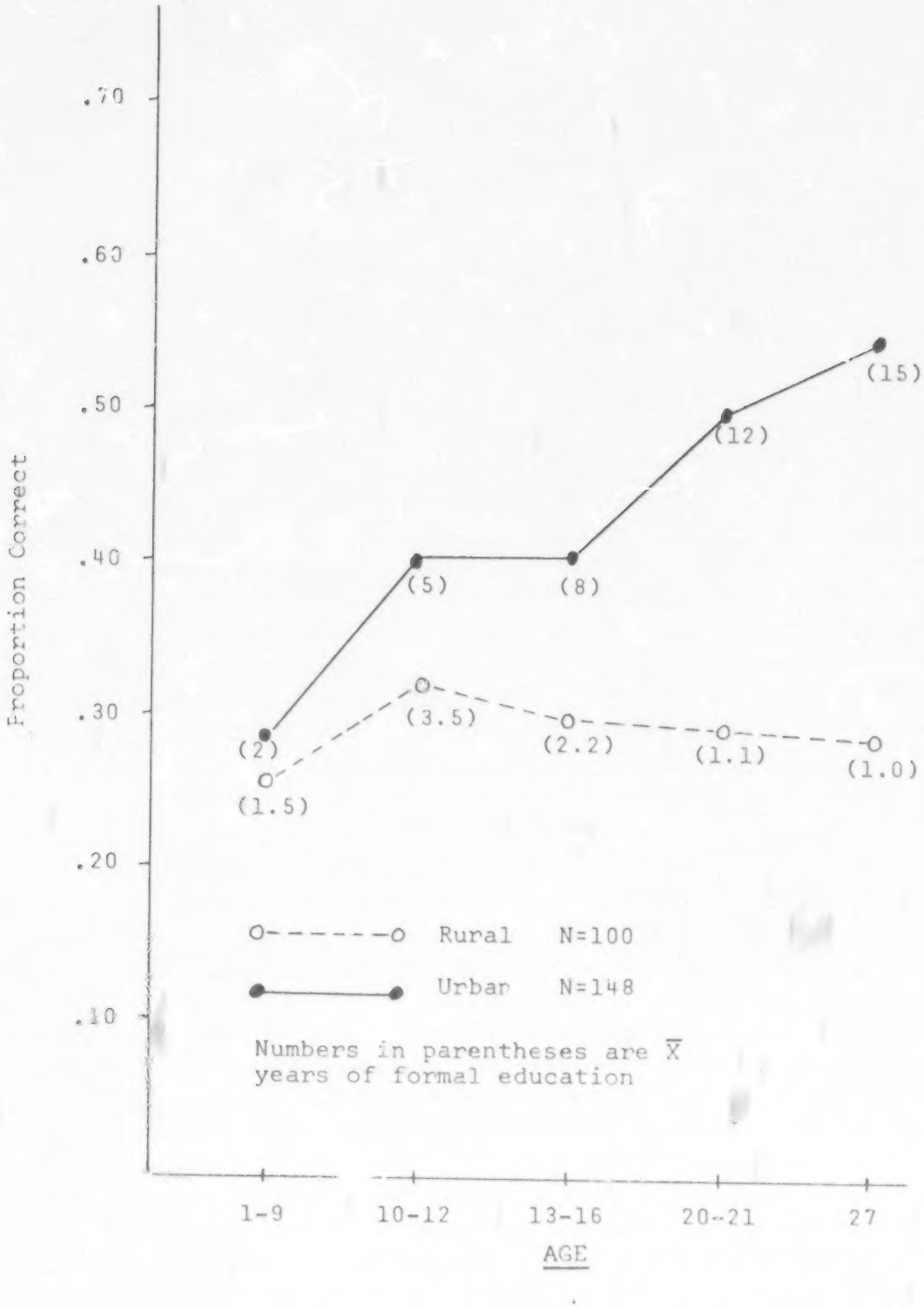


Figure 8 - Results of Wagner STM Study

and Klein conclusion that education does not influence memory development. However, the important proviso to be added to this conclusion is that only a very low level of education was sampled in that work (1-3 years). Wagner's results, combined with those of Kagan and Klein and our own research in Liberia would lead us to expect education-related differences in performance only at a relatively high level (greater than sixth grade).

The present experiment tests these expectations.

Subjects

Subjects were all residents of Ticul, Yucatan and were selected, haphazardly, ten to a group: from each of the five following subject populations:

(1) 7-9 year old second grade students

(2) 11-13 year old second grade students

(3) 11-13 year old fifth and sixth grade students ($\bar{X}$=5.4)

(4) 13-16 year old seventh and eighth grade students ($\bar{X}$=7.3)

(5) 14-17 year old ninth grade students

Thus, it can be seen both age and education are controlled at the lower levels of education. The important comparisons come between the different levels of education in secondary school.

Stimulus Materials and Procedures

The stimuli used in the picture sorting experiments, twenty commonly nameable objects from the categories clothing, food, animals, and utensils served as the to-be-recalled stimuli in this study.

The subjects were told that the experimenter had a list of 20 words that he would read one at a time for five times and that he would be expected to remember as many of the words as possible after each presentation. The list was then read in a quasi-random order with the restriction that no two items from the same semantic category occurred adjacently in the list. Five different list orders were constructed and the order of list presentation counterbalanced according to a Latin square design. After a list had been read at about a two second/item rate, the subject was asked to recall as many items as possible.

The major results of this study are presented in Figure 9. The top part of the figure plots the total number of

correctly recalled items for each trial as a function of age/education. It is clear from the figure that recall improves over trials and that the more highly educated secondary school students perform better than all other groups. Contrasts (F groups=11.94; d.f.=4,45; $p < .01$; F trials=35.68; d.f. 4,180; $p < .01$. The groups x trials interaction was only marginally reliable F=1.48; d.f.=16,180; $p < .10$) using the Newman-Keuls procedure with $\alpha = .01$ indicated that in addition to the older secondary school students being reliably different than all other groups, the fifth and seventh - eighth graders, while not differing from each other, were reliably better than

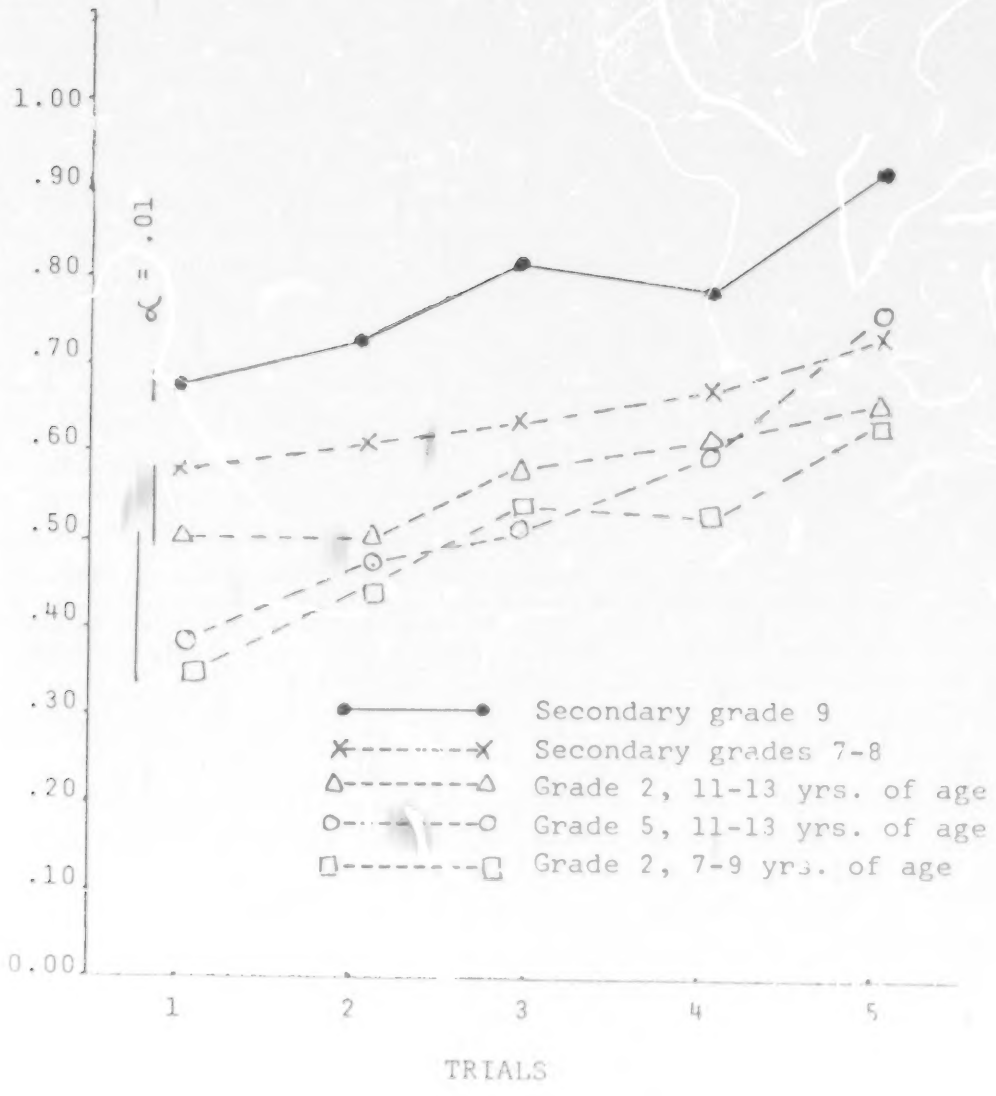


Figure 9

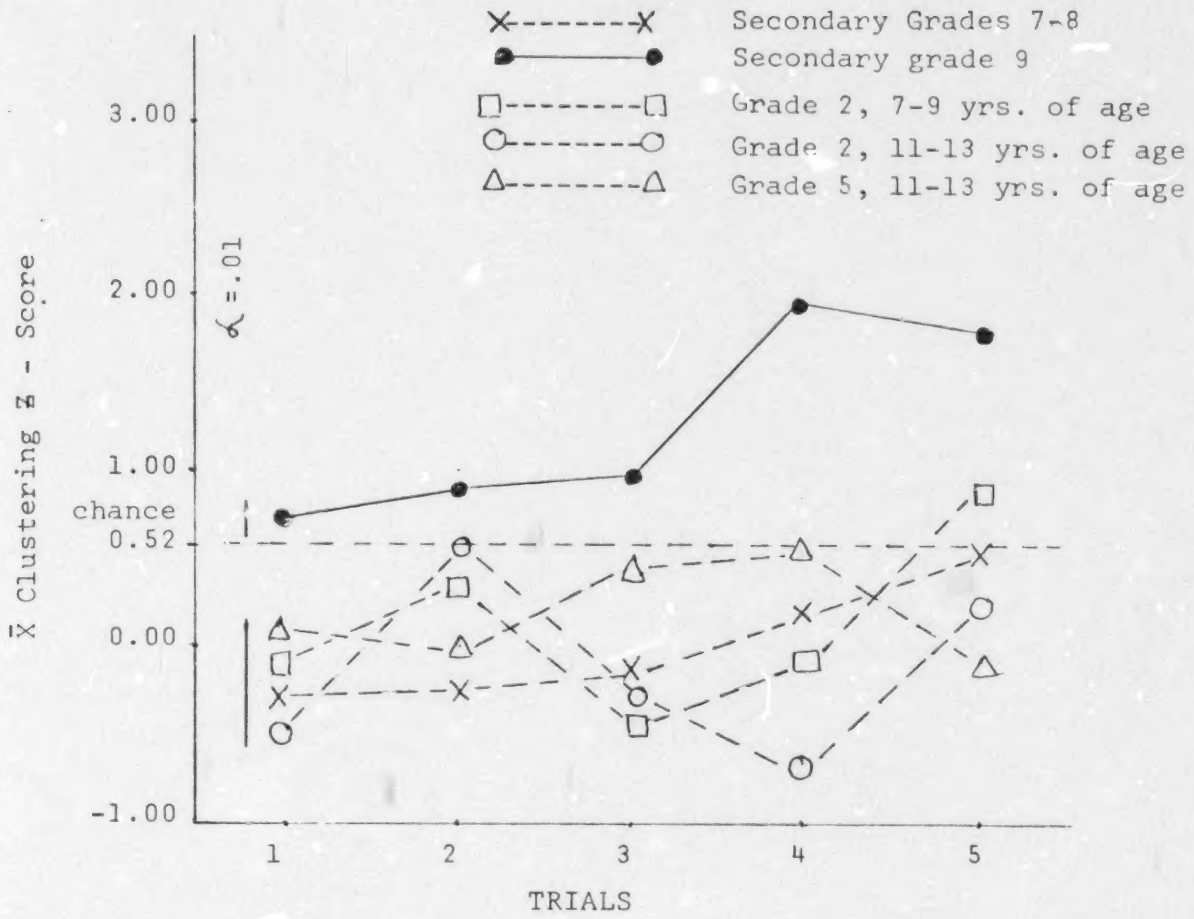


Figure 9 -

the remaining groups which did not differ from each other.

The bottom panel of Figure 9 plots the amount of category clustering as a function of groups and trials. Here, it is clear that only the oldest and most educated group manifests category clustering at a level greater than chance (F groups= 11.06; d.f. 4,45; $p < .01$), and only this group increases the amount of clustering very much over trials (F trials-2.37; d.f.=4,225; $p < .05$).

We also carried out an analysis of the serial position function relating performance to the ordinal position of items in the list. In contrast to the performance in Wagner's short term memory task, all groups in the present experiment showed better recall for items presented near the beginning of the list, although the amount of such"primacy" increased with education.

Although the number of subjects involved in this study was not as substantial as in Wagner's study, both point to education as an important factor influencing memory performance on two rather divergent tasks. We see no contradiction between these results and the data reported by Kagan and Klein working with a similar group of Mayans in rural Guatemala in so far as within country comparisons of educated and non-educated subjects are concerned. In no case that we have observed is there a really marked difference in the performance of educated and non-educated groups on these memory tasks until a relatively high level of education is attained. We cannot make a judgement about the relative performance of our subjects and American children because the educational sophistication represented by grade level is almost certainly different in the two countries not to mention cultural differences (in "richness of environment" for example) that make between country comparisons impossible.

The differences between results on the free recall and short term memory tasks are almost certainly worth further exploration. From the prospective of current research on memory (e.g. Murdock, 1974) we should expect that people who show no primacy in Wagner's short term memory task would also fail to show it in the free recall task. There are, of course, many explanations why this might not be so.

I. Verbal Logical Problems

Research in quite different parts of the world (Luria, 1971; Cole et al., 1971) indicates that relatively low levels of education influence subjects' responses to verbal logical problems such as syllogisms. While the basis for this change is by no means clear (c.f. Scribner, 1974b), it appears that the educated subjects more readily accept the problem as self-contained information to be evaluated in its own right, while uneducated subjects are likely to "assimilate" the problem to their own past experience. The present study follows the basic design of the previous studies in this report in an attempt to determine the influence that educational or other experiences have on responses to verbal logical problems.

The verbal logical problems adapted from previous research in Liberia (c.f. Cole et al., 1971, ch. 6) were presented to a variety of subject populations in the Yucatan. The problems are listed in Table 27.

Insert Table 27 Here

---

(1) A dog and a horse are always together; the horse is here now; where do you think the dog might be now?

(2) Where the earth is good crops are good; the earth in Kilometro 71 is good; do you think the crops are good?

(3) Women from Guadalajara are pretty; my friend is from Guadalajara; do you believe my friend is pretty?

(4) The houses in Mexico City are large; my friend has his house in Mexico City; how do you think that his house might be?

(5) If Juan and Jose drink a lot of beer, the mayor of the town is angry; Juan and Jose are drinking a lot of beer now; do you think the mayor is angry with them?

(6) So that Jose might be able to carry corn from his farm to the town center he needs a cart and a horse; he has the horse, but doesn't have the cart; Can Jose carry the corn from his farm?

(7) In a chicken coop if a hen is eating or a rooster is eating, the turkey wants to eat; the hen is eating, but the rooster is not eating; do you think the turkey wants to eat?

(8) If in a chicken coop a hen and a rooster are eating together, the turkey wants to eat; the hen is eating now, but the rooster is not eating; do you think that the turkey wants to eat?

(9) If Juan and Jose don't drink a lot of beer the mayor is angry with them. Juan is drinking a lot of beer now, but Jose is not drinking; do you think the mayor is angry?

(10) In order to work well one has to give a horse enough to eat; Jose gives his horse enough to eat; do you think Jose's horse works well?

Table 27

Problems for logical problems study

The problems were read to the subject one at a time in either Spanish or Maya (whichever language was more convenient for the subject) and the subject was first required to answer the question and then to explain the reason for his answer.

Subjects

Subjects were drawn from the following subject populations:

(1) first and second grade students from Ticul, Yucatan ($\bar{X}$ age=8.8; $\bar{X}$ grade=1.85) N=33

(2) non-literate or near non-literate Mayan adults from Ramonal, Quintana Roo ($\bar{X}$ age=32.1; $\bar{X}$ grade=0.69) N=32

(3) non-literate Mayan adults from Ticul ($\bar{X}$ age=48.9) N=41

(4) mestizo adults from Ticul ($\bar{X}$ age=34.1; $\bar{X}$ grade=3.52) N=36

(5) mestizo adults from Ticul ($\bar{X}$ age=36.5; $\bar{X}$ grade=4.16) N=30

(6) fourth, fifth, and sixth grade students from Ticul ($\bar{X}$ age-12.4; $\bar{X}$ grade=8.70) N=30

Results

The results may be evaluated both in terms of the proportion of correct responses given by each population group and in terms of the reasons given for the choice of response. Summary results are given for the proportion of correct responses in Figure 10 and in Table 28. In the upper half of the data table, data are presented for the mean number of correct responses (out of a possible 10), while in the lower half of the table the proportions correct for each problem are presented. Figure 10 plots those proportions in the order from most difficult (problem #8) to least difficult (#6). Looking first at the summary results, we find that educational experience plays a key role in performance, beginning somewhere around grade 3. This generalization is supported by analysis of variance (F groups=25.37; d.f.=6,226; p .01) and individual contrasts using the Newman-Keuls procedure with α=.01 where we see that the secondary school students ($\bar{X}$=9.7) perform better than all other groups, that the subjects with a

Insert Table 28 Here

	Mayan adults Ramanal, Q.Roo	1st & 2nd grade students, Ticul, Yuc.	Mayan adults, Ticul, Yuc.	Mestizo adults 1 Ticul, Yuc.	Mestizo adults 2 Ticul, Yuc.	4th-6th grades Ticul, Yuc.	Secondary students Ticul, Yuc.
Number of subjects in Group	32	33	41	36	30	31	30
Mean Age	32.1	8.8	48.9	34.1	36.5	12.4	15.9
Mean Grade	0.69	1.85	0.00	3.52	4.16	5.09	8.70
Mean Number Correct	4.53	5.33	6.17	7.28	7.63	7.80	9.66
Problem 1	.38	.42	.66	.83	.80	.78	1.00
Problem 2	.50	.54	.81	.91	.87	.94	1.00
Problem 3	.34	.54	.76	.91	.90	.94	1.00
Problem 4	.50	.76	.61	.91	.90	.94	1.00
Problem 5	.63	.85	.73	.85	.83	.97	1.00
Problem 6	.87	.85	.78	.94	.90	.97	1.00
Problem 7	.28	.30	.59	.69	.73	.87	.97
Problem 8	.06	.03	.02	.11	.17	.26	.90
Problem 9	.25	.21	.46	.69	.73	.65	.87
Problem 10	.84	.88	.61	.86	.77	.94	1.00

$\alpha = .01$

Table 28

Summary table for logical problems experiment

third to sixth grade education (the two groups of Ticul, mestizos and the fourth - sixth grade students ($\bar{X}$=7.45 correct and $\bar{X}$=7.80 respectively)) perform about equally and significantly better than the remaining groups (Mayan adults from Ticul, $\bar{X}$=6.2; first and second graders, $\bar{X}$=5.3; Mayan adults from Ramonal, $\bar{X}$=4.5). However, some experience other than education must have some effect on responses to this kind of situation because the Mayan adults from Ticul respond significantly better than a comparable population from the smaller, more traditional town of Ramonal Quintana, Roo, in spite of the fact that mean years of education are in the opposite direction from that predicted. It is difficult to speculate on what experiential variable is most likely to account for this result, but the fact that most Mayans in Ramonal are campesinos engaged in agricultural tasks while many of the Mayans from Ticul are engaged in some sort of trade may well be important, not to mention the fact that the towns differ markedly in their contact with the outside world.

Several further analyses have been done on these data to assess the importance of education within the adult populations which had experienced at least some education. Correlations and partial correlations were run between age, number correct, and years of formal education (where applicable). In each case there was a significant positive correlation between grade and number correct. The correlations and partial correlations between age and number correct were never significant in the positive direction, although in one case (the Mayan adults from Ramonal) there was a significant negative correlation between age and number correct with years of education partialed out. This result almost certainly reflects the greater traditionalism of the older of the subjects in the group.

The analysis of the relationship between population group and proportion of correct responses for each of the individual problems presented graphically in Figure 10, indicates that population differences in terms of number correct were by no means uniform across problems, but tended to appear on the problems which were, on the average, more difficult.

The introduction to this section pointed out that one of the possible reasons that populations differ lies in the fact that less educated subjects tend to assimilate the problem to their own past experience. Presented in Figure 11 is the analysis of subject justifications for the adult Mayan groups combined and the adult mestizo groups. Where Figure 10 gives number of correct, Figure 11 gives a correct score only if the subject's justification was logically consistent with the problem. Inspection of Figure 11 readily demonstrates that the two groups of adults differ markedly, with the Mayan adults both from Ticul and from Ramonal giving far more justifications that were external to the information given in the problem as

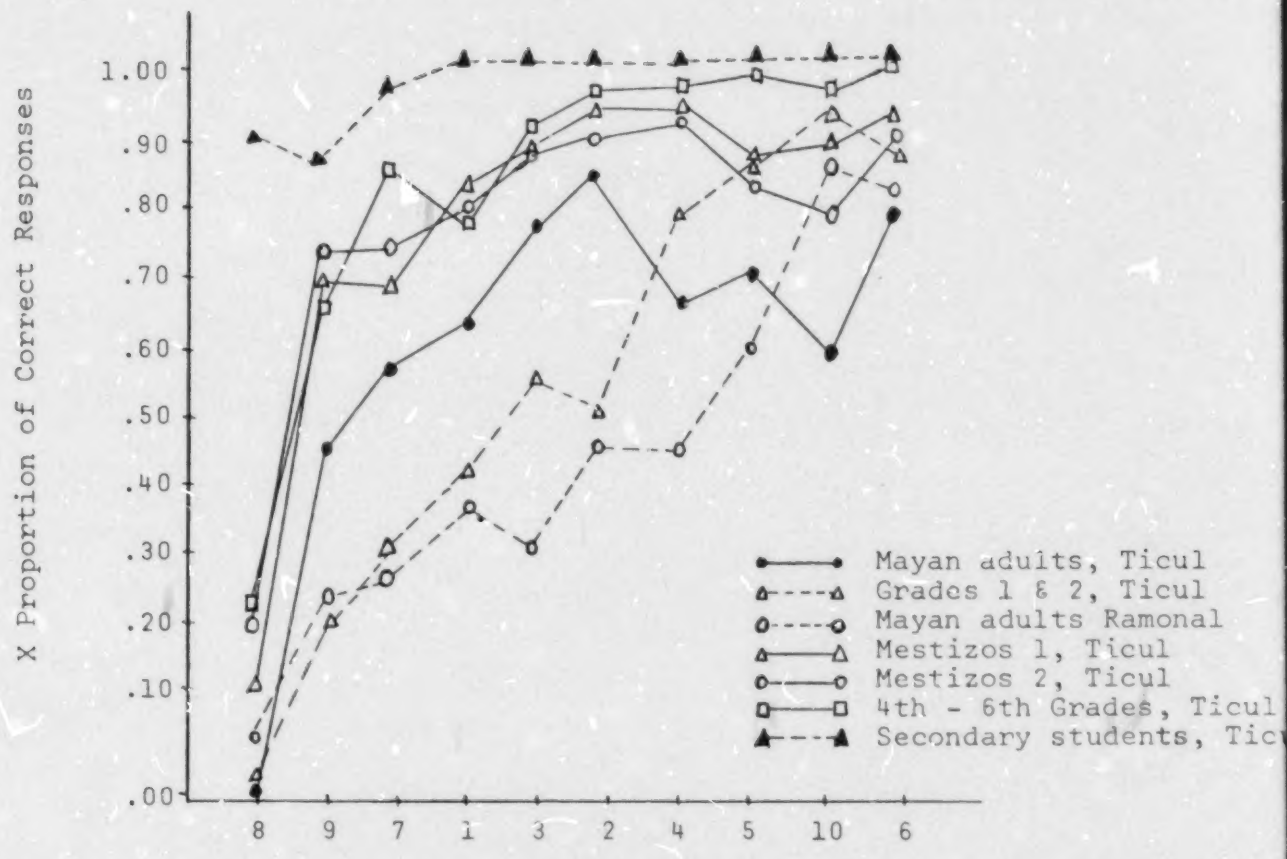


Figure 10 Analysis of Problems

a self-contained unit. Perhaps most informative of all are the syllogisms on which the two groups of subjects do not differ markedly (i.e. #'s 5, 6, and 10). These are precisely the three on which a correct answer is completely in tune with the experience of the subjects, i.e. mayors get angry with drunks, horses need food to work, and some sort of vehicle is needed to carry corn from a farm, but the nature of women from Guadalajara, houses in Mexico City and the farmland at Kilometro 71 are another thing all together.

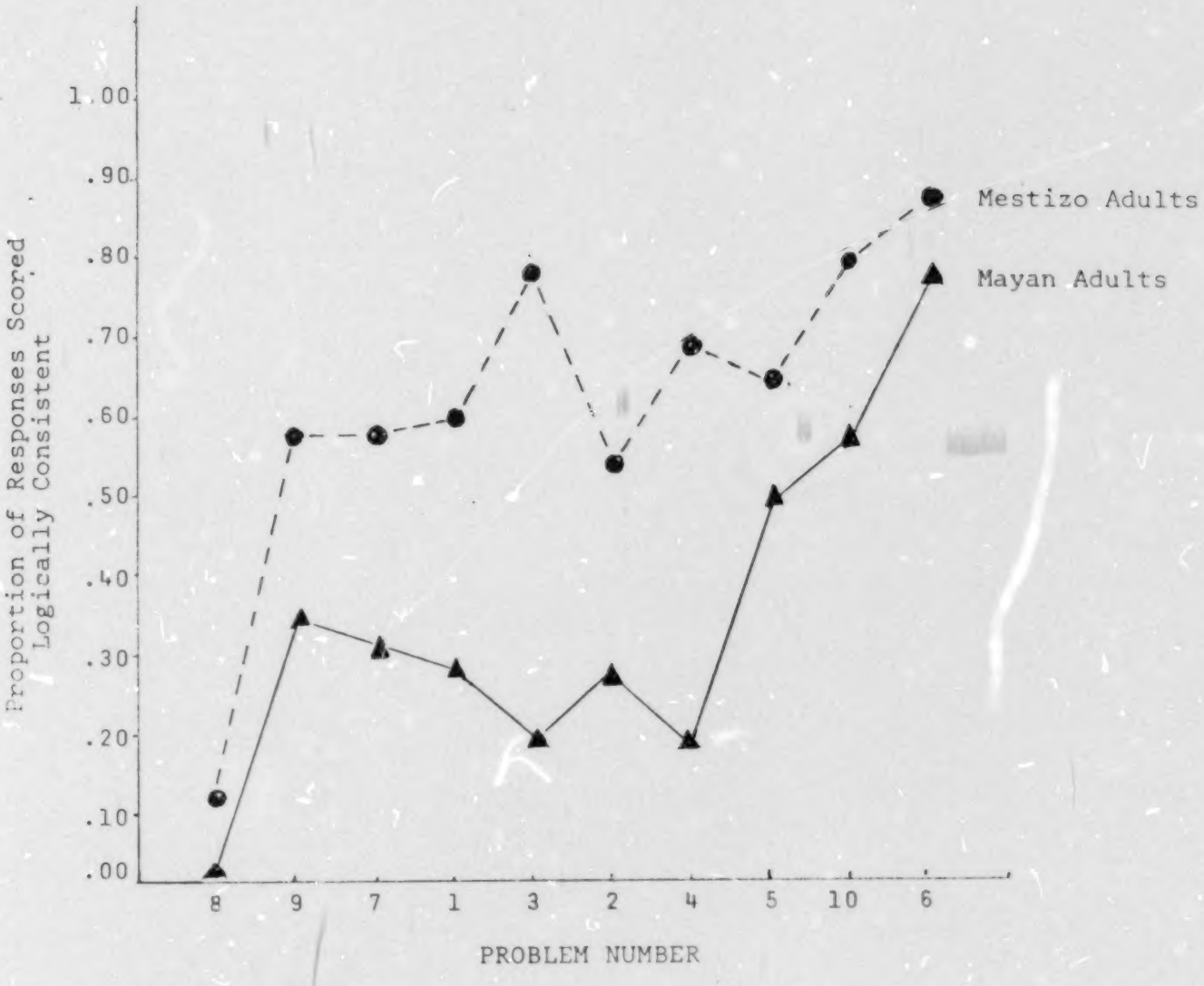


Figure 11 -

J. A Within Subjects Study of Age and Educational Variations in Cognitive Performance

During the period in which the previous studies were being conducted, two colleagues from Harvard University, Jeremy Anglin and Joy Skon, designed a study based upon an adaption of Thurstone's Primary Mental Abilities test (Thurstone, 1938). The Thurstone subtests were chosen because they sample widely from a number of areas of intellectual activity and overlap in many instances with experimental studies which were carried out with independent groups of

subjects in all our other work. In addition, Anglin and Skon also took a somewhat different approach to subject selection. Working primarily in Ticul (although some of the subjects were selected from Bacalar, some 250 kilometers to the south east), they selected pairs of subjects from the same family - either siblings or cousins. These pairs were selected to provide a range of educational experiences from a few years of primary school to completion of preparatoria and a range of differences in educational experiences within families from no difference to several years difference in educational experience.

Subjects

Pairs of subjects from seventeen families participated in this study. They ranged in age from 11-25 years and in educational experience from 2-12 years.

Materials

Nine different sub-tests were adapted from Thurstone's (1938) monograph on primary mental abilities for use with Mestizo children and young Mestizo adults. The test names and a brief description of each are included in the following:

(1) Verbal analogies; two words are connected by a certain relation. The first word of another pair is presented and the subject's task is to choose one of five possible comparison words which completes a verbal analogy equivalent to the example pair.

(2) Arithmetic; the subject is asked to add, subtract, and multiply using paper and pencil if he (she) wishes.

(3) Completion of a number series; these numbers are given in series and the subject must complete the series in a manner that is consistent with the principle that generated the first three numbers.

(4) Reasoning; the subject is given a complete syllogism and is asked to judge whether or not the conclusions follow from the premises.

(5) Perceptual analogies; each problem consists of eight figures. The first three are called A, B, and C and the next are numbered 1 to 5. The subject's task is to pick from the five comparison figures the one to place with C that will create an analogy to A-B.

(6) Arithmetic reasoning; subjects were presented five verbal problems involving arithmetic calculations that could be done without paper and pencil.

(7) Vocabulary; a target word was presented along with five comparison words. The subject's task was to select the comparison word closest in meaning.

(8) Memory; there were two memory sub-tests. First, a set of 20 nonsense figures were presented for inspection and the subject had to identify the 20 from a set of 60 figures including the original 20 and 40 distractor items. The second memory task was in effect a single trial paired associate test with two digit numbers as stimuli and responses. After studying the original stimulus-response pairs, the subject was presented the stimuli and asked to provide the responses.

(9) Figure classification; the subject was shown pairs of panels each containing several figures. Some rule (such as all the figures in the first panel are oriented vertically, all those in the second panel horizontally) distinguished the panel. Using figures in a third panel which contained figures selected according to the principals used in the first two panels in a scrambled arrangement, the subject had to indicate his understanding of the principals involved.

(10) Twelve items from the Raven Matrices Test.

Procedures

In general the procedures followed those recommended by Thurstone in his presentation of the tests and results (Thurstone, 1938, pp. 22-57). At the start of the testing session each subject was told about the general contents of the tests by Angel Vela, a local resident of Tical who had extensive experience as an anthropological-linguistic informant and experimenter. The actual tests were administered by Sr. Vela. Ms. Skon checked the appropriate presentation of the materials, observed and recorded subjects' responses.

Following Thurstone, an example of the procedures and a correct answer (or appropriate performance) were given for each test in addition to extensive verbal explanations and provisions for asking questions. Each item was scored using the procedure, or a procedure analogous to procedures outlined by Thurstone. A composite score for each test as well as a composite score over tests (a total "primary mental abilities" score) were calculated for each of the subjects.

Results

(1) Owing to experimental error, data were not collected on a few sub-tests of the PMA test for some of the subjects. To render summary data comparable, all subjects were assigned a total PMA score that represents this raw score as an average of all the sub-tests to which they contribute data.

(2) As with the similarities study above, the arrangement of testing conditions and the nature of the data rendered the data most easily analyzable in terms of correlational analysis rather than analysis of variance.

(3) Consequently a step-wise multiple regression analysis with age, sex, and years of formal education as independent variables was run on the Total PMA Score and each subtest for which there were data from all subjects.

The results of this analysis were particularly clear cut. For the over-all PMA score the correlation between education and performance was .75. Neither age nor sex correlated significantly with over-all PMA performance and the addition of these two variables in a regression equation contributed only negligibly to the multiple correlation coefficient.

In general, analysis of the sub-tests of the PMA test and Raven matrices yielded the same conclusions. Education was the only significant contributor to regression equations involving five of the seven sub-tests for which data was available from all subjects.

Education was not a significant predictor in only two cases. Sex ($r=0.55$) was the only significant predictor of performance on the verbal analogies sub-test (#1) and age ($r=0.33$) was the only contributor to the reasoning sub-test (#4). In only one case (the recognition of figures sub-test #8a) did the use of multiple correlation techniques improve the fit of the regression equation. While years of education ($r=0.42$) was the largest contributor of the multiple correlation of 0.63 both the inclusion of sex and age improved the final result.

Discussion

These results are in general agreement with the data from the individual experiments reported in earlier sections of this report. Years of educational experience is by far the most pervasively effective demographic variable related to test performance.

The two exceptions to this generalization in the case of PMA sub-test performance are difficult to interpret. On the surface, the reasoning sub-test is quite similar to the verbal logical problems study reported above. Yet in the case of the problems from the PMA test, age, not education was the primary predictor of performance - (the only parallel in verbal logical problems was that the considerably older Mayan adults from Ticul did significantly better than those from Ramonal, but then it must be recalled that the partial correlation between age and performance for Ramonal was significant in the negative direction). Only further research could tell us whether this result arises from differences in the way the problems were constructed, the range of age and educational

experience sampled, or some other factor.

The emergence of sex as a major determiner of the verbal analogies performance has only one counterpart in the previous studies, performance on the verbal similarities problems, where sex emerged as a minor, but reliable predictor of performance. The similarities between the two tasks can be readily seen, but the reasons for sex as a significant predictor are at this point completely open to speculation.

Appendix 1

Mean Salary and Social Position Ratings
for the Most Common Professions on Demographic
Survey Plus Comparisons for State of Yucatan

	Profession	$\bar{X}$ Rated Salary (pesos daily)	$\bar{X}$ Rated Position
1	Student	0.00	2.64
2	Tijidos	4.90	1.93
3	Washing & Ironing	14.80	2.21
4	Domestic Work	15.00	2.29
5	Farmer	20.10	1.75
6	Embroidery	20.30	2.61
7	Henekinero	21.30	1.82
8	Campesino	21.80	1.96
9	Weaves Hammocks	25.70	2.28
10	Waiter	28.30	2.64
11	Hat Maker	30.80	2.57
12	Baker	31.50**	2.21
13	Journeyman, Obrero	31.80	2.21
14	Potter	36.10	2.64
15	Agricultor	36.70	2.64
16	Mason	42.20	2.75
17	Highway Work	43.70	2.57
18	Tailor	47.90	3.00
19	Shoe Maker	44.60	2.96
20	Chofer (Trucks)	49.30	3.00
21	Nurse	51.20	3.50
22	Taxi Driver	61.10	2.93
23 *	Teacher	62.50	3.71
24 *	Professor	62.90	3.71
25	Mechanic	65.30	3.21
26	Gov't. Employee	69.60	3.21
27	Technician (All Types)	78.20	3.61
28	Businessman	87.10	3.57
29	Contractor	117.50	2.75
30	Engineer	157.10	4.53
31	Lawyer	215.70	4.29
32	Doctor	257.10	

r=+.77 Raters were 20 businessmen from Ticul and surrounding towns, the two parts were presented in counterbalanced order on different days. Professions listed represent 90% of total reported in ethnographic survey.

* These are effectively the same and were presented at different points in the list as a consistency check.

** Federal Minimum.

Data are for May 1974

Appendix 2

The Prediction of MODERNITY

The results of the analysis using MODERNITY as a dependent variable are summarized in Figure 2. Both grade completed and degree of regular attendance are effective determinants of MODERNITY as a result of the deliberate efforts of teachers to provide a modernizing influence. However, the effect of HLANG and PASOC also have a significant direct effect indicating the influence of parental, cultural, and economic factors.

It is interesting that SCHOOL, TOWN, and SEX do not directly affect the MODERNITY of the respondent as measured by the instrument used here.

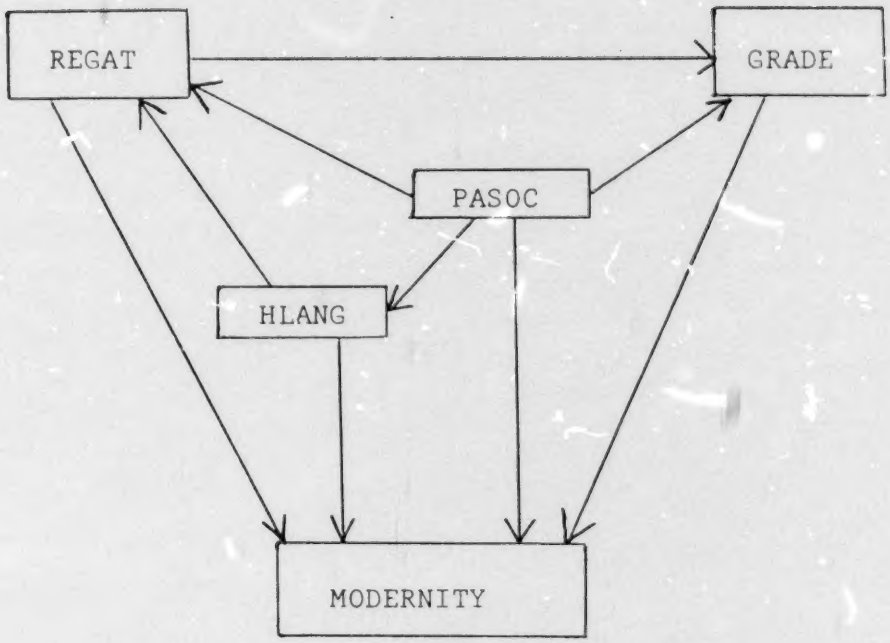


Table 1, Appendix 2: Summary of the relationship among those variables which contribute directly to modernity and their combined effect. The model indicates that all five variables are intricately related in that nine of the ten possible unidirectional relationships are included; however, the model is highly informative since none of the other variables considered in Table 8 were necessary; R^2=.39.

Appendix 3

Questions on Educational Survey and Scoring Scheme for WAIS and Modernity Scale Items

1) Have you studied (been to school)? Why did you stop studying (or fail to go to school)?

2) Can you read and write?

3) Have you repeated a grade? If yes, how many times?

4) Do you have any brothers and sisters? If yes, what is their sex, age, years of education?

5) Did your father go to school? How old is he and how many years of schooling does he have?

6) Did your mother go to school? How old is she and how many years of schooling does she have?

7) Do you have children? What are their ages and how many years of schooling do they have?

8) (If you have children) do you think that it is important that your children study?

   a) It is not important
   b) It is important for some children
   c) It is important for all
   d) It is very important for all

9) Do you think that it is necessary to go to school to do well in Mexico? Why?

10) Do (did) your parents think that it is (was) important to go to school?

   a) Not important
   b) Perhaps it is (was) important
   c) It is (was) important
   d) It is (was) very important

11) What do your brothers and sisters think?

12) What (minimum) grade of study do you think is necessary for a man to live well in Mexico?

   a) Some primary
   b) Primary
   c) Secondary
   d) Technological, preparatory, normal
   e) Professional
   f) More than professional

13) Do you think that a woman ought to have the same studies as a man?

14) What languages do you speak? What was your first language?

15) What languages do you speak in your home?

16) Do you think that a woman has the same opportunity to study as a man in Mexico? Why?

17) Was there a school in your town? What grade did it go to? How far was it to (from) your house? Who paid your school expenses?

18) What work does (did) your father do?

19) What work do you do?

20) Have you had other jobs? What were they?

21) Did you help your parents when you were studying. Did you miss classes? If yes, how many times?

22) Have you traveled to or lived in other towns? Which were they?

23) How much money do you think that it is necessary to earn daily to live well in Mexico?

24) What work would you like to do to earn this money?

25) Have you helped other members of your family to go to school? How many and to what grade?

26) Where would you like to live if it were possible?

27) Would you like to continue studying (or go to school)?

28) What profession would you like to have?

29) What do you want to do when you finish studying?

30) What is the most important reason for which students do not continue studying?

a) Problems with their families
b) Because there is no school near
c) Responsibilities that make it impossible to go
d) Money for their expenses
e) The opinion of their family or friends

31) Some think that only the rich can study. What do you think?

32) What do you think of those that do not continue studying after they finish their primary education?

33) Some say that school is responsible for problems in the family. What do you think?

34) Do you believe that those that have primary education have more opportunity than those that do not?

35) What do you think is the most important for the future of your country?

a) The hard work of the people
b) The good plans of the government
c) God's help
d) Good luck

36) Have there been times in the past when you have thought a lot about a national problem such as social security for the aged and children and want to do something?

a) Never
b) Occasionally
c) Often

37) If you were to meet a person that lived in another country many kilometers from here, do you think that it would be possible to understand the way in which he thinks?

38) Which are the problems that you think that the country has today?

39) How often do you read the news in the paper?

a) Every day
b) Every week
c) From time to time
d) Never

40) Professors and teachers in universities are studying things like the factors that determine if a child is a boy or a girl and the way in which a seed changes into a plant. Do you think that these investigations are:

a) Very good
b) At times good
c) At times bad

41) Two boys of twelve years of age were working on a farm, and while they worked they were talking about how to grow more corn in less time. The two decided to ask their fathers about the problem when they returned home. That night the father of one boy said that their thoughts on the matter

were a good thing and that it was very important to give consideration to problems such as growing more corn in less time. The father of the other said that the way to grow corn was the way in which it had always been done and that things like changing it would be only to lose time and nothing more.

Which father do you think said the wisest words, the first or the second?

42) WAIS: I have here a group of words that are in pairs and I want you to tell me in which way they appear alike or if they do not appear alike or have no relation (Presented in this order).

1) pineapple - banana
2) corn - squash
3) machete - hoe
4) pot - frying pan
5) horse - goat
6) watermelon - potatoes
7) woman - boy
8) man - horse
9) honey - water
10) fly - tree
11) gasoline - wood
12) bicycle - automobile
13) cedar - mahogany
14) air - water

Scoring for Modernity and WAIS

1) Modernity

Total score is equal to the sum of:

Question # 35	0 = God's help; good luck 2 = People's work; Government plans
Question # 36	0 = Never; 1 = Occasionally; 2 = Often
Question # 37	0 = Not able; 1 = Able
Question # 39	0 = Never; 1 = From time to time; 2 = Daily
Question # 40	0 = Very bad; at times bad 1 = Very good; at times good
Question # 41	0 = Traditional; 2 = Experimental

Total Possible = 10

2) WAIS

(0) Subject says a and b are not related
(1) Subject says a and b are related or are similar on the basis of physical attribute, common use or function, or similar environment.
(2) Subject related a and b by a superordinate category (i.e. both are animals) or abstract concept (i.e. both are necessary for life).

Appendix 4

Results of Free Association Pilot Study of Instructional Variation

Subjects were 20 Mayan adults 18-47 years of age ($\bar{X}$=33.0) who had no formal education. Instructions and procedures were the same as detailed for experiment 1 above with the exception that all examples of responses to the noun stimuli were adjectives instead of mixed adjectives, verbs, and nouns. Results are presented in Figure 1. Analysis of variance confirmed the strong visual impression of the effect of instructional set in a highly significant groups x form class of response interaction ($F=97.94$; $d.f.=2,36$; $p < .01$).

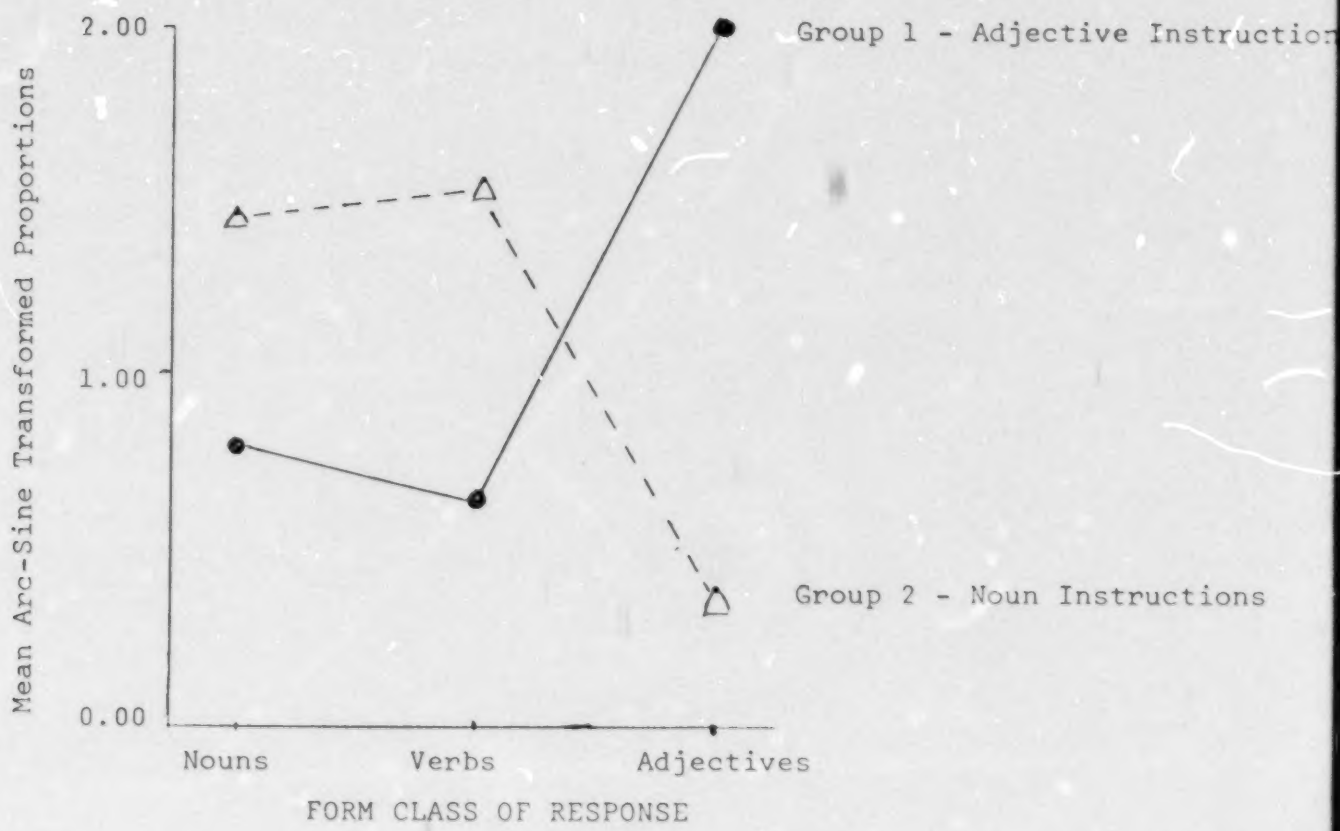


Figure 1 - F.A. Pilot Study Results

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